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COMPETITIVE DESIGNS FOR A PERMANENT bridge across the Neva in St. Petersburg, Russia, are called for by the Town Board of that city and plans of the site and a full detail of the borings made—as well as the full conditions of competitions, are on file in this office. These plans call for a bridge 847 ft. long and 91 ft. wide between balustrades, with a roadway 72.1 ft. wide. A draw-span must be provided giving a clear opening of at least 98 ft. The abutments and piers must be of stone protected by heavy ice-breakers; but the design of the bridge is left entirely to the competitor, under conditions of loading and stress given. The piers must be founded on caissons sunk by compressed air, or otherwise; the caissons to be sunk to an average depth of about 100 ft. to a stratum of hard clay and boulders, passing through silt, sand and clay strata. All designs must be submitted before Sept. 14, 1902; and out of the plans submitted, the three best will be selected and to the designers of these prizes of $6,000, $4,000 and $2,500 will be awarded; or, 12,000, 8,000 and 5,000 rubles. These plans will then belong to the Board, which also retains the right to buy any of the rejected plans by paying 2,000 rubles, or about $1,000 for each. Winning the prize does not give the designer the right to make the working plans nor to build the bridge. To assist in making estimates a list is given of approximate prices for the items of bridge construction in St. Petersburg.

THE SAN FRANCISCO & PIEDMONT RAILWAY, incorporated in California on Dec. 12, with $2,500,000 capital, is said to propose the construction of a steel tubular tunnel under the bay, connecting San Francisco and Oakland. The company is backed by the Realty Syndicate, having large landed interests in Piedmont. The articles of incorporation authorize the company to operate ferry boats in connection with a railway line connecting Emeryville and Leona Heights; but it may also build a tunnel 1½ or 2 miles long, as the government may authorize.

THE NEW YORK RAPID TRANSIT RAILWAY extension to Brooklyn as planned by the Rapid Transit Commission is receiving considerable criticism at the hearings of the Supreme Court Commission now sitting. This Commission consists of Wm. C. Bryant, Richard H. Laimbeer and Frederick R. Kellogg, and was appointed on Oct. 14. Its duty, according to the provisions of the Rapid Transit Act, is "to determine and report after due hearing, whether such railway ought to be constructed and operated," and to report its findings within 60 days. The commissioners have held nearly continuous hearings since their appointment and on Dec. 14 they applied for an extension of time in which to perform their work. This additional time was granted by the court, and the hearings are being continued. As planned, the extension of the rapid transit line which is proposed runs from the New York City Hall down Broadway to Battery Park, thence under the East River to the Brooklyn City Hall, and thence to the Long Island R. R. station in Brooklyn. A double track road throughout is proposed. In all of the hearings of the special commission strong objections have been raised to the two-track line as inadequate, and it has been urged that a four-track line be substituted.

THE FIRST 8,000-HP. UNIT IN THE NEW POWER house of the Manhattan (Elevated) Ry. in New York city was started during the past week. There are to be eight of these units in all, with a normal rating of 64,000 HP. total, corresponding to a maximum of 100,000 HP. Each unit consists of a duplex compound engine direct-connected to a 5,000-K-W. Westinghouse revolving-field alternator. At each end of the crankshaft, on which the generator is centrally placed, is a high-pressure and a low-pressure cylinder. The former is placed in horizontal, the latter in vertical position, both connecting rods acting on the same crank-pin. The revolving field of the generator, 32 ft. in diameter, will act as flywheel. The engines were built by the E. P. Allis Co., of Milwaukee, Wis.

A WATER-POWER PLANT WITH ELECTRIC TRANSmission has just been put into operation at the village of Labarge, about 40 miles west of Lansing, Mich. A new crib dam was constructed across the Thornapple River, on the site of an old mill dam, and a power house erected to develop 500 HP. with a head of water of 18 ft. High tension alternating current is generated, and transmitted to the neighboring villages of Hastings, Middleville, and Nashville, a longest distance of over 30 miles, where the current is stepped down and used for lighting purposes. The line will probably be extended to other towns in the near future.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a butting collision between two limited passenger trains near Uplands, Cal., on the Southern Pacific Ry. So far as is known at present, at least two persons were killed outright and a large number of others injured, several fatally. It is stated that the collision was due to the northbound train running past the siding at Uplands where it had orders to wait to let the southbound train pass.——A despatch from Nashville, Tenn., states that on the afternoon of Dec. 21 a train went off a high trestle near that city. Three men are reported killed and a number injured.

THREE FATAL BOILER EXPLOSIONS occurred in Pittsburg during the last week. On Dec. 20 a battery of four boilers exploded in bar mill No. 3 of the Black Diamond steel works of Park Bros. The mill and the adjoining boiler shop of Jas. McNeil were destroyed. Three men were killed and a number injured in the explosion and the subsequent collapse of the buildings.——A boiler in the plant of the American Steel & Wire Co. on Neville Island exploded on Dec. 20. One man was killed; the plant was considerably damaged.——On the morning of Dec. 21 one boiler of a battery of five at the Singer, Nimick & Co. plant of the Crucible Steel Co. blew up. About thirty men were injured, eight of them seriously; of these at least two will probably die.

A FALL OF ROCK IN THE BERGEN TUNNEL of the Erie Ry. at Jersey City, N. J., on Dec. 21, caused the wreck of two passenger trains and completely tied up traffic on all the Erie lines running westward from New York for an entire day. About 7 a. m. a mass of rock fell from the roof of the tunnel, which is lined only in a few short sections about 100 ft. in from the eastern end, and breaking in the fall, it blocked both east and westbound tracks. Almost at the same time a westbound passenger train from Jersey City to Nyack and an eastbound train from Greenwood Lake to New York ran into the obstructing masses of rock, both trains being wrecked. The Greenwood Lake train was crowded with passengers bound for New York, and a panic ensued among them. The engineer and fireman of the eastbound train were the only persons seriously injured; the fireman's injuries were fatal.

A GAS-EXPLOSION IN A BLAST FURNACE at the plant of Jones & Laughlin, in Pittsburg, resulted in the death of nine men and the serious injury of several others. The men were at work on the furnace top when the accident occurred; molten metal, slag, etc., were thrown out by the explosion of a quantity of gas in the furnace and fell upon the men, burning them to death.

THREE RESERVOIRS FAILED between Ashland and Frackville, Pa., as a result of the heavy rain of Dec. 13. They were located upon the same stream, within a distance of some three miles. The two upper reservoirs belonged to the Haupt Estate, of Frackville, and the two lower ones formed a portion of the water-works of the borough of Ashland, Pa. The dam forming the uppermost reservoir, which was used for the production of ice, gave way and soon filled the one below, which was empty, and broke through its dam. Thereupon the flood washed out a large section of the upper dam of the Ashland water-works, and damaged the lower dam somewhat.

GAS FROM A WATER-WORKS WELL exploded at Wauseon, O., on Dec. 14, wrecking the pumping station and injuring two men. One of the men died the next day.

ELECTROLYSIS AT ST. PAUL, MINN., has become so threatening that the street railway companies have been notified by the water board to take immediate steps to prevent damage to the water mains.

THE ABOLITION OF GRADE CROSSINGS AT LYNN, Mass., has been favored by a vote of 22 to 9 in a joint convention of the two branches of the city council. It appears that a commission will be appointed to decide on a plan, but it is understood that a majority of the council favors elevation of the tracks, rather than depression, and that such a plan will be advocated before the commission.

BONDS FOR WATER PURIFICATION WORKS at Pittsburg have at last been authorized by the city council. It is expected that bids for construction will be invited in a month or so. The initial appropriation is $1,500,000, which will cover 60% of the present estimated cost of the works. Mr. J. Guy McCandless is Director of Public Works; Mr. Morris Knowles, Assoc. M. Am. Soc. C. E., is Resident Engineer of the Bureau of Filtration, and Mr. Allen Hazen, M. Am. Soc. C. E., 220 Broadway, New York city, is Consulting Engineer.

HEARINGS ON THE PROPOSED CHARLES RIVER dam will probably be opened at Boston, on Jan. 13. The object of the dam is to form a water park for Boston and vicinity. The members of the investigating committee are as follows: Henry S. Pritchett, President Massachusetts Institute of Technology; Col. S. M. Mansfield, U. S. Engineers Corps, New York city, and Richard H. Dana, Cambridge, Mass.

BIDS FOR A RICE IRRIGATING POWER PUMPING plant are wanted until Jan. 2, 1902, by John W. Maxcy, Consulting Engineer, Houston, Tex. The contract will include the delivery and erection of the plant at a point about seven miles from Crosby, Harris Co., Texas. The plant must be guaranteed to raise 70,000 gallons per minute through either one lift of 65 ft. or two lifts of 32½ ft. each.

THE DEVELOPMENT OF THE RAPIDS OF THE OHIO River at Louisville, Ky., has been made the subject of a preliminary canvass for plans by the Commercial Club of Louisville. Fourteen plans were received by the committee which the club appointed for the purpose, and two out of the number were recommended by the committee for further consideration. The successful plans are the work of J. N. Gathright and H. W. Graham, respectively, both of Louisville. It is probable that a hydraulic engineer will be engaged to make a complete investigation and report of the possibilities of power development at Louisville.

CULPABLE NEGLECT OF THE BROOKLYN BRIDGE is charged in the presentment of the Grand Jury recently sitting to investigate the accident of July 24 and the expert engineers' report upon the causes of this accident. The character of the neglect is thus described in the presentment:

> The Grand Jury finds from the evidence before it that the New York and Brooklyn Bridge has never been either regularly or systematically inspected, and that its management in this regard has by no means been in accord with that which would naturally characterize its management had it been private property under the control of a good business man, charged with responsibility, charged with its safety. Methods of inspection well known and even common among bridge engineers have been wholly omitted, and we are satisfied that if the bridge had been periodically subjected to a proper systematic inspection such an accident as that of July 24 last would have been avoided. We further find that during the period under consideration such inspection of the bridge as did take place was made by carpenters, riggers, riveters and such mechanics, wholly undirected and uninstructed as to methods by any engineer, and that, too, at no stated time and no regular intervals, and that their so-called inspection did not in any case include a comprehensive inspection of the bridge as a whole, even by such methods as might suggest themselves to these mechanics. Though the evidence before us tends to show culpable neglect in this regard, in the management and maintenance of the bridge, yet in view of certain extenuating circumstances, which, however, will not hereafter apply, this neglect is not, in our opinion, of the character designated by the statute as "wilful," or such as to demand the present indictment of those responsible for such management.

The jury also puts forward the following recommendations:

> First—That as soon as is reasonably possible there shall be made by or under the immediate direction and supervision of a competent engineer, a more rigid and complete inspection of the entire structure than was possible, in the limited time at their disposal, for the engineers examined before us who are not regularly connected with the bridge.
>
> Second—That the future management of the bridge shall require similarly rigid and complete inspection by the best methods, at stated and frequent intervals; that such inspection shall be made by or under the direct supervision of a competent engineer, who shall be responsible for the thoroughness and completeness thereof and the sufficiency and accuracy of the written reports of the same which he shall be required to make as each inspection proceeds; that these parts of the bridge in which any break or disarrangement has occurred or may occur, and which are vital to the safety of the bridge, be watched with the greatest care and frequency, so that upon the first appearance of a defect or break the same may be immediately corrected and prevented from extending. In our opinion proper inspection would require practically the entire time of such engineer.
>
> Third—That some system of regulating the traffic on the bridge be adopted in order to avoid special strain at any one point, such as resulted in the buckling of the lower chords of the stiffening trusses on an occasion prior to the accident above referred to.

TESTS OF FIREPROOF PARTITIONS BY THE NEW YORK BUILDING DEPARTMENT.

Fire and water tests of sixteen different fireproof partitions were conducted on Aug. 26, Sept. 30 and Nov. 21, 1901, under the supervision of the Department of Buildings of New York city. From the full reports of these tests made by Mr. W. W. Ewing, the Engineer of the Department, which have been furnished to Engineering News, the following particulars of most general interest have been abstracted. The tests were conducted under the direction of Mr. Ewing, and according

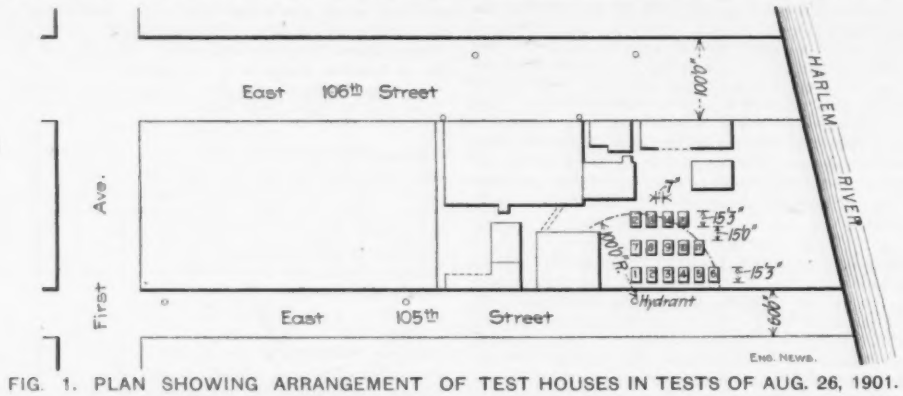


FIG. 1. PLAN SHOWING ARRANGEMENT OF TEST HOUSES IN TESTS OF AUG. 26, 1901.

(In the succeeding tests of Sept. 30 and Nov. 21 the Test Houses occupied the sites of some of the houses first tested, which were torn down to make room for the new buildings.)

to the specifications for test houses and mode of procedure formulated by him, but the partitions were in each case erected by the person or firm controlling the manufacture of the construction submitted for test.

Fig. 1 shows the plan of arrangement of the test houses for the test of Aug. 26. The tests, as a whole, are by far the most comprehensive in scope of any series of partition tests yet conducted, as we have pointed out in our editorial columns.

PURPOSE OF TESTS.—The object of the tests was to record the effect of a fire of one hour's duration, ocmmencing at 500° F. and increasing to 1,700°F., followed by the application of a hose stream of water on the fire side, which lasted 2½ mins. The area of each partition under investigation was required to be at least 137.75 sq. ft., with a width of 14 ft. 6 ins., and a height of 9 ft. 6 ins. The time allowed for the construction and drying of the partititon was about two weeks. The

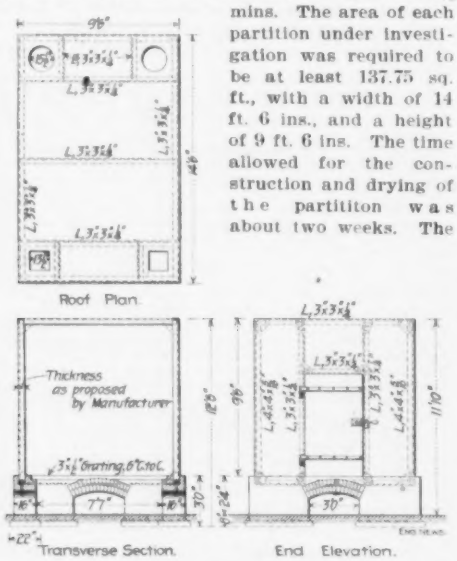


Fig. 2. Details of Test House for Testing Fireproof Partitions; Department of Buildings, New York City.

framework which held the several forms of partitions to be tested was similar in each case, and was constructed as follows (Fig. 2):

Upon a 12-in. thick dwarf brick wall, 2 ft. 4 ins. above the ground, laid in cement mortar, and having four through-draft openings, one on each wall face, extending from the ground to the bottom of the ⅛ × 3-in. iron grate bars spaced 6 ins. on centers; an angle-iron framework was built, having two sides 14 ft. 6 ins. long and 9 ft. 6 ins. high, within which the special forms of fireproof partitions were set. The front, back and top of each kiln was enclosed in a manner similar to the sides, suitable flues being provided in each corner of the roof plate. Each door opening was hung with an iron or special built-up door, which opening was used for the purpose of refiring and making observations during the test. The fuel used was pine and mixed hard cord-wood, the fire being accelerated at the start with a supply of commercial kerosene. The temperatures were measured with a new platin-rhodium pyrometer. One hundred feet of hose with 1⅛-in. nozzle and water at hydrant pressure was used.

PLASTER COMPOSITION BLOCK PARTITIONS.

BELL PARTITION.—This partition, manufactured by H. K. Bell, Fourth Ave. and 139th St., New York city, consists of plaster composition blocks, laid on edge with mortar so as to break joints and plastered over. As arranged for the test, one wall consisted of hollow blocks, and the other wall consisted of solid blocks, of the forms and dimensions shown by Fig. 4. The composition of the hollow blocks was, by weight, two-fifths plaster and three-fifths cinders, "with a small quantity of other materials, averaging about ½-lb. per sq. ft." Both forms of blocks were laid by bricklayers using a mortar consisting of one pail of King's brick mortar, two pails of sand and one-third pail of plaster. Both walls were plastered on both sides with a ½-in. coat of King's Windsor cement, and the coat on the inside was white-finished.

The results of the test were as follows: The fire was started at 11.36 a. m.; at 12.11 p. m. the temperature was 1,058° F., and it gradually increased to 1,724° F. at 12.43 p. m.; at 12.47 p. m. water was applied for 2½ mins. on each partition. On Aug. 28, two days after the test, an examination of the kiln was made. It was found that about two-thirds of the cells of the hollow blocks on each side were exposed, the inner wall of the block having been calcined and washed away. About two-thirds of the 2-in. solid blocks of the other partition had calcined, and were washed away to a depth of 1 in. Generally the plaster with which the partitions were finished had lost its bond with the blocks. The portions of the blocks not washed away were not affected by the fire and water, the sections showing the material to be in a normal state. In no place had the fire or water passed through the partitions.

METROPOLITAN PARTITION.—The construction of this partition, built by the Metropolitan Fireproofing Co., 13 Burling Slip, New York city, is fully shown by the sketch, Fig. 5. The manufacturer gave the following composition of the blocks used in the partitions tested: Plaster of Paris, 75%; wood chips, 20%; cocoanut fiber, 2½%; asbestos, 2½%. The partitions were plastered with King's Windsor "browning" plaster. One partition, that on the east side, was the company's regular construction shown by Fig. 5, but the other was an experimental partition made of 12 × 12 × 1¾-in. blocks connected by a different clip.

The test was as follows: At 11.06 a. m. the fire was started, temperatures of 1,742° F. and 2,030° F. being obtained at 11.32 a. m. and 11.50 a. m., respectively. At 11.57 a. m. the temperature was 1,796° F., and at 12.06 p. m. water was applied to the east partition for 2½ mins., and to the west partition for 30 secs., when it fell. The examination of the partitions two days after the test showed that the west partition had deflected about 4 ins. from the heat, and that a considerable area had been knocked out by the hose stream. The other partition withstood the test. The plaster had been destroyed and the blocks had calcined to a depth of about ½-in.; the metal clips were effective.

NORMAN PARTITION.—This partition, manufactured by the Norman Fireproof [illegible] Co., of 41 Union Square, New York city, is [illegible] of rectangular blocks laid on edge, either [illegible]ally or horizontally, and supported by metal [illegible]rights and turnbuckle tie rods. The wes[illegible] partition, shown by Fig. 6, had the blocks set [illegible]ontally and the east partition had them set ve[illegible]y. The manufacturers gave the following sp[illegible]tion of the composition of the blocks used:

Our block is what is commonly called a [illegible] made 2 ins. thick, composed of plaster, [illegible] other ingredients intended to harden and re[illegible] component parts are 2 of plaster of Paris [illegible] fiber, and a small quantity of cocoanut fiber [illegible] in to add strength. We use 7 lbs. of plast[illegible] 1 sq. ft., and 1½ lbs. of wood fiber to 1 sq. [illegible] ter used was King's "browning."

The test was as follows: The fire [illegible] started at 10.30 a. m., and at 11.06 a. m. the te[illegible] temperature had reached 1,346° F. This temperatur[illegible] gradually increased to 1,706° F. at 11.25 a. m. [illegible] 11.30 a. m. water was applied for 2½ mins. on [illegible] partition. The effects of the fire and wat[illegible] were as follows: On the west partition, where [illegible] water did not strike, about one-fourth the area of plaster remained, but where the water [illegible]ock the blocks were calcined and were washed away to a depth of from ¾-in. to 1 in. On the east partition about one-fourth of the plaster remained, but elsewhere the plaster was removed and the blocks were calcined and washed away to a depth of ½-in. In no place had the fire or water passed through the partition, and the portions of the blocks not washed away were in good condition.

SANITARY PARTITIONS.—The construction of this partition, manufactured by the Sanitary Fireproofing & Contracting Co., 442 E. 106th St., New York city, is shown by Fig. 7. The blocks have concave-grooved edges, and are pierced with holes for the insertion of metal rods. They are composed of one part plaster and two parts ashes mixed with water, combined with a small quantity of fluid cement designed to harden the block. For the test one partition was made of blocks 2 ins. thick and the other of blocks 3 ins. thick, all the other dimensions being the same in both. The 2-in. block partition was plastered on both sides. On the inside one-half of the area was covered

Fig. 3. View of Typical Test House for Fireproof Partition Tests of New York Department of Buildings.

with a ½-in. coat of Platt plaster, and the other half with a ½-in. coat of common sand and lime hand-made brown mortar. On the outside there was a ½-in. coat of King's Windsor "browning" mortar. The 3-in. partition was plastered on the inside with a ½-in. coat of Platt plaster.

The test was as follows: The fire was started at 3.14 p. m., and at 3.40 p. m. a temperature of 1,140° F. had been attained, which gradually increased to 1,832° F. at 4.06 p. m. At 4.14 p. m. water was applied to each partition for 2½ mins. Where the water did not strike the partitions the plaster remained in place, but could be easily removed by hand. Both the 2-in. and the 3-in.

blocks had been calcined and washed away for a depth of ½-in. The fire or water did not penetrate the partition.

WHITE PARTITIONS.—These partitions were submitted for test by the White Fireproofing & Construction Co., 162 West 27th St., New York city. Both were block partitions, but one was constructed of cellular blocks, as shown by Fig. 8, and the other was constructed of solid blocks of the same dimensions. The manufacturers gave the following description of the composition of the blocks:

"When excelsior is used as the fibrous material, 5 to 10% of same is used in combination with 75 to 80% of plaster of Paris, and 15% of asbestos. When excelsior is used it is to be treated with some fireproofing solution to render it fire resisting. When cocoanut or sisal fiber is used as the fibrous material, 5% of same is used, combined with 80% of plaster of Paris and 15% of asbestos.

The plaster used in finishing this kiln was a ½-in. thickness of Adamant "browning" mortar, placed on each side of the partitions. The following is the complete log of the test:

10:00, fire started; 10.02, the west side partition cracked at the middle of partition, both horizontally and vertically; back cracked from side to side at middle; 10:03, east side cracked from side to side at middle section; 10:07, steam issuing from cracks in west partition for a short interval; 10:17, temperature 644° F.; 10:20, temperature 1,148° F.; 10:25, temperature 1,346° F.; 10:36, temperature 1,346° F.; 10:37, temperature 1,490° F., partition on east side deflected outwardly; the west and south side partitions both deflected inwardly; 10:40, temperature 1,589° F.; 10:50, temperature 1,760° F.; 10:58, temperature 1,688° F.; 11:00, water applied for 2½ mins. on each partition.

The effect of the fire and water was as follows: The 2-in. solid partition had calcined and was washed away to a depth of ¾-in. The inside shell of about 16 blocks in the central portion of the hollow block partition was calcined and washed away to a depth of about 1¼ ins. The bond of the plaster on the inside walls had been destroyed. In no place had fire or water passed through the partitions.

FREEMAN-DOBBIN PARTITIONS.—The construction of this partition, built by Freeman-Dobbin Fireproofing Co. of New York city, is shown by Fig. 9. It is a plaster composition block partition, the block being composed of two parts plaster of Paris, one part silicate of lime and carbonate of lime, and one part of fiber and fibrous pulp composed of equal parts of excelsior and wood fiber. One partition was built of cellular blocks, as shown by Fig. 14, and the other was built of solid blocks 2 ins. thick, but of the same lateral dimensions as the cellular blocks. These blocks were set on edge so as to break joints in a mortar made from putty and sand gaged with plaster of Paris, and a ½-in. coat of the same mortar was applied to each side of both partitions.

The test was as follows: The fire was started at 2.55 p. m. on Sept. 30, and at 3.35 the temperature had reached 1,760° F. The temperature rose to 1,8?2° F. at 3.39, and then gradually fell to 1,560° F. at 3.46. At 3.55 p. m. water was applied for 2½ mins. to each partition. The partition was examined on Oct. 2. In the cellular block partition about two-fifths of the blocks had the inner wall calcined, and washed away, so as to expose the cells, and about four-fifths of the plaster had lost its bond and was washed away. In the solid block partition about ten blocks at the center had been calcined and washed away to a depth of about 1 in., and the whole of the plaster coat had disappeared. The parts of the blocks of both partitions which remained in place were not affected. In no place had the fire or water passed through the partitions.

METAL LATH AND PLASTER PARTITIONS.

NEW YORK EXPANDED METAL CO.'S PARTITION.—The construction of this partition, built by the New York Expanded Metal Co., of 253 Broadway, New York city, is shown by Fig. 10. The partition is composed of metal uprights 1 × 3-16-in., spaced 12 ins. apart c. to c., and covered with expanded metal, known as B expanded metal lathing, which weighs 0.3-lb. per sq. ft., being made in sheets 13 ins. wide and 96 ins. long, and expanded with openings ⅜-in. wide and ½-in. long. This metal measures about No. 25 U. S. Standard Gage in thickness. This framework of uprights and expanded metal was covered with a scratch and browning coat of King's Windsor mortar on both sides, and on the inside with a finish of white putty plaster, the whole making a partition 2½ ins. thick.

The test was as follows: At 1.20 p. m., Sept. 30, the fire was started. The temperatures reached were 572° F. at 1:35; 1,040° F. at 1.42; 1,706° F. at 1.47; 2,021° F. at 2.11, and 1,632° F. at 2.15. At 2.20 p. m. the water was applied to each partition for 2½ mins. An examination of the partitions the day after the fire showed the following effects of the test: The browning coat on the outside of the east partition had fallen for about two-thirds the area of the partition. The outside scratch coat was intact. The inside browning coat had been washed away by the water. On the west partition a 2 × 2-ft. square of the outside browning coat and about four-fifths of the inside browning coat and one-half of the inside scratch coat had been washed away. In no place had the fire or water passed through either partition.

MOESLEIN PARTITIONS.—This partition, built by the Moeslein Ceiling Works, of New York city, is shown by Fig. 11. It was constructed of T-iron uprights, 1 × ⅛-in., spaced about 11 ins. apart c. to c., and covered with perforated sheet metal on each side, forming an air space of 1⅝ ins. between the metal sheets. Both sides of the partition were covered with King's Windsor scratch coat dry mortar, no browning being used.

The test was as follows: The fire was started at 3.50 p. m., Sept. 30, and at 4.25 a temperature of 1,724° F. had been attained. The temperature gradually increased to 2,021° F. at 4.46, and four minutes later water was applied to the west partition for 2½ mins. On Oct. 2, the partition was examined. About five-sevenths of the plaster on the inside of the partition was washed away, and the ironwork appeared to be somewhat warped by the heat. The plaster on the outside of the partition had partly lost its bond. In no place had the fire or water passed through the partition.

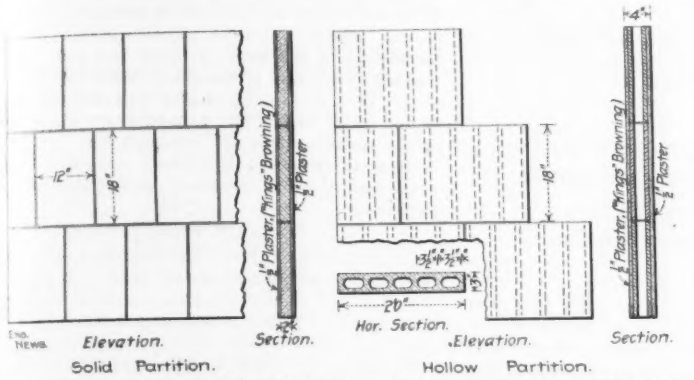


FIG. 4. BELL PLASTER COMPOSITION BLOCK PARTITION CONSTRUCTION.

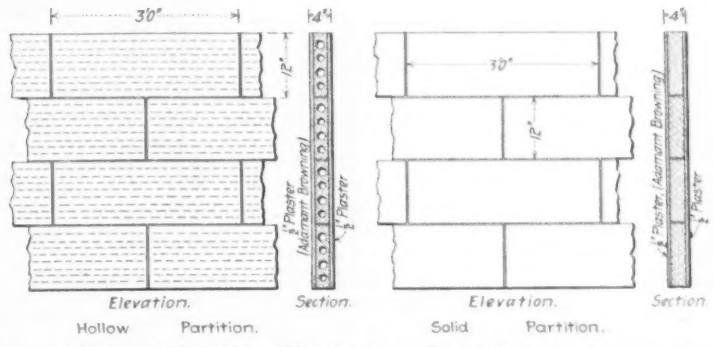


FIG. 8. WHITE PLASTER COMPOSITION BLOCK CONSTRUCTION.

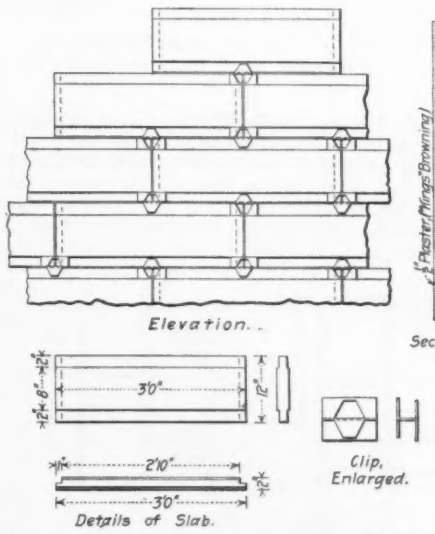


Fig. 5. Metropolitan Plaster Composition Block Partition Construction.

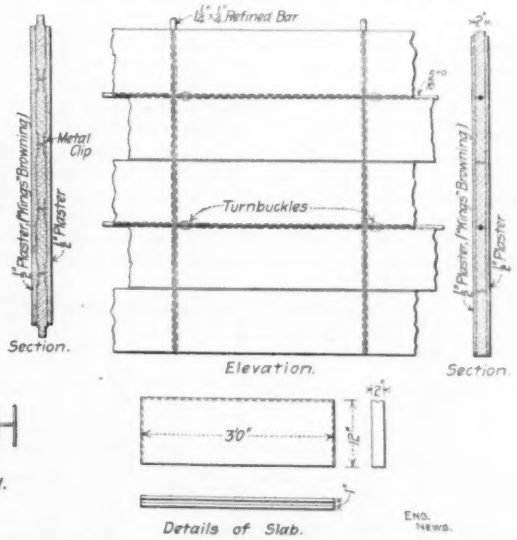


Fig. 6. Norman Plaster Composition Block Partition Construction.

ROEBLING PARTITIONS.—The construction of this partition, built by the Roebling Construction Co., of New York city, is shown by Fig. 12. As described by the manufacturer, this partition was built as follows: To 2 × ⅛-in. metal uprights was attached on both sides No. 22 wire ⅜-in. mesh stiffened by ¼-in. steel rods spaced about 7 ins. apart. The space between the wire mesh lath formed an air space, and on the outside of the lath on each side of the partition was placed a ½-in. coat of "Rock Wall" plaster. On the inside of the partition this coating was finished with a white putty coat of plaster.

The test was as follows: The fire was started at 2.34 p. m., Sept. 30, and in 20 mins. had reached a temperature of 1,814° F. From this time on the temperature fluctuated between 1,500° and 1,994°; at 3.25 p. m. it was 1,868° F., and one minute later water was applied to the east partition for 2½ mins. The effect of the test, as shown by the examination on Oct. 2, was to wash about three-fifths of the plaster from the inside wall. The plaster on the outside wall was intact, and in no place had the fire or water penetrated the partition.

On Nov. 21, a second partition, built by the same company, and of the construction shown by Fig. 13, was tested. Metal lath, of the same character as that used in the first test, was attached to one side of ⅞ × ⅞-in. channel uprights, spaced 16 ins.

apart c. to c., and was plastered on both sides with Acme patent plaster. The total thickness of the finished partition was 2½ ins. The test was as follows: The fire was started at 1.15 p. m., and the temperature fluctuated between 900° and 1,000° F., until 1.40, when it reached 1,220° F. From this time on there was a gradual and steady increase of temperature to 1,706° F. at 2 p. m. The temperature then fluctuated between 1,600° F. and 1,800° F. until 2.15 p. m., when water was applied to one partition for 2½ mins. An examination of the partition on Nov. 22 showed that about one-fourth of the inside finish coat of plaster had been washed away, and that both coats had been washed away in two spots of from 1 to 1½ sq. ft. in area, exposing the ¼-in. tie rods. In no place had the fire or water passed through the wall, but during the fire test vertical cracks along the lines of the studs appeared in the outside plaster coat, from some of which steam issued.

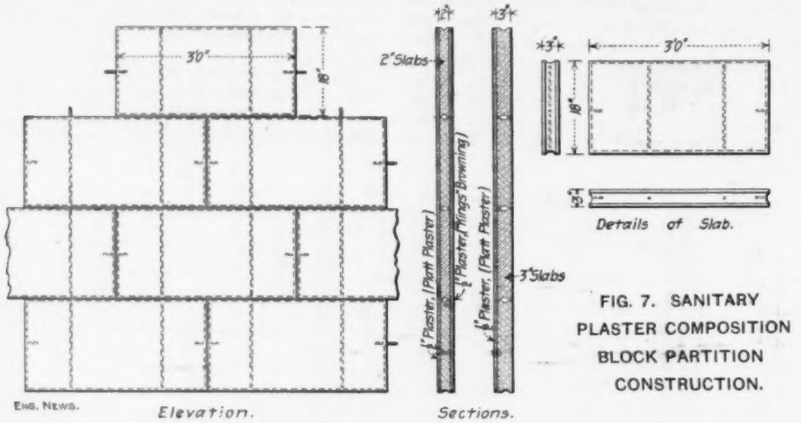


FIG. 7. SANITARY PLASTER COMPOSITION BLOCK PARTITION CONSTRUCTION.

AVERILL PARTITIONS.—The construction of these two partitions, built by Geo. F. Averill, of New York city, is shown by Fig. 14. The west partition was composed of 3-16 × 1-in. flat uprights, spaced 12 ins. apart c. to c., and fastened at the top and bottom by 3-16 × 1-in. plates. On the outside of this framing was attached Schratweiser metal lath. This metal construction was plastered and filled in with Averill sawdust and hydraulic cement composition to a thickness of about 1 in., the inside of the filling being flush with the metal uprights. On top of this sawdust filling, both inside and outside, were placed a scratch and browning coat of sand mixed with hydraulic cement, making the total thickness of the partition about 2½ ins. The east partition was built of 17 × 36 × 2-in. blocks, composed of the Averill composition of sawdust and hydraulic cement. These blocks were plastered on each side with a scratch and browning coat of sand cement mortar. The partition was about 3 ins. thick when completed.

The test was as follows: The fire was started at 2.23 p. m., and at 2.44 p. m. the temperature had reached 1,832° F. It then gradually increased to 2,102° F. at 2.55 p. m., and held this figure until water was applied to the partitions at 3.23 p. m. On Nov. 22 an examination of the test kiln was made. In the east wall, where hte 2-in. block partition was used, the blocks had been calcined and washed away to a depth of 3-16 to ¾-in. at several points. Half of the area of the east partition had lost the inside scratch and browning coat of sand and hydraulic cement that was applied to the sawdust and hydraulic cement filling between the studs. This filling was calcined and washed away to a depth of from ¼ to ¾-in. in 18 small spots, comprising together about 7 3-5 of the area. In six different places the filling had been washed away so as to expose the metal lath. The outside of the partition was entirely intact. In no place had the fire or water passed through either partition.

SCHRATWIESER PARTITION.—This partition, manufactured by Mr. C. Schratwieser, 426 Third Ave., New York city, consists of plastered metal lath carried by a framework of angles (Fig. 15). The partitions tested were described as follows by the manufacturer:

Solid partition 2 ins. thick, constructed as follows: 1½-in. × 1½-in. angle-iron top and bottom plate, 1-in. × 1-in. angle-iron stud places 12 or 16 ins. on centers. [illegible] lace four times to each, Schratweiser's sheet met[illegible] one side. Plastered on both sides with King's [illegible] asbestos cement, dry mortar, to a thickness [illegible] Finish both sides with a white finishing coat [illegible] Hollow partitions, 3 ins in thickness, constructed as follows: 1½ × 1½-in. angle irons, top and bottom [illegible] 1-in. angle-ior studs places 12 or 16 ins. on cen[illegible] studs, lace four times to each, Schratwieser's pate[illegible] metal lath on both sides, plastering on both sid[illegible] King's Windsor asbestos cement dry mortar, to a [illegible] of ¾-in., making a total thickness of 3 ins. Fi[illegible] sides with a white finishing coat of plaster.

The test was as follows: The fire was sta[illegible] at 3.40 p. m., but an accident to the pyrome[illegible] prevented any record of the temperatures fro[illegible] taken, although it was probable that they [illegible] up to the standard set by the other tests. [illegible] p. m. water was applied for 2½ mins. to ea[illegible] partition. About one-third of the plaster on the metal lath of the west partition was burne[illegible] and washed away, and in one place having an a[illegible] of about 18 × 7 ins. the plaster was washed [illegible] to the metal lath. The plastering on the outside of the partition was not damaged, and the metal framework was not materially affected. In no place had the fire or water passed through the partitions.

TILE BLOCK PARTITIONS.

Henry Maurer & Son.—The construction of these two partitions, built by Henry Maurer & Son, and the National Fireproofing Co., of New York city, is shown by Fig. 16. The west partition was composed of 12 × 9 × 2-in. hollow blocks, with three cells each, the walls of the blocks being about 11-16-in. thick. The material of the blocks was what is known as "porous" material. The blocks were laid up in a mortar of one part natural cement and three parts sand, so as to break joints. In each horizontal joint a soop metal strap ⅞-in. wide, and No. 24 U. S. Standard gage in thickness, was inserted. The east partition was made up of 8 × 12 × 3-in. blocks, with two cells, laid in a one part natural cement and three parts sand mortar, so as to break joints. No hoop iron straps were used. The material of the blocks was what is known as semi-porous material.

The test was as follows: The fire was started at 3.20 p. m., Sept. 30; the temperature reached 1,832° F. at 3.54 p. m., and gradually increased to 2,057° F. at 4.18 p. m. At 4.20 water was applied for 2½ mins. to each partition. The partition was examined on Oct. 2. The only effect of the fire and water had been to remove the plaster from a portion of the inside of each wall. Wherever the plaster remained the bond was intact.

BRINKMAN PARTITION.—This partition, manufactured by S. G. Brinkman, 639 W. 148th St., New York city, consists of solid terra-cotta blocks laid on edge in courses so as to break joints, and having the adjacent courses bonded by means of a special I-beam, as shown by the sketch, Fig. 17, supported by metal uprights. In the test the two partitions employed were exactly the same, except that one was made of 2 × 9½ × 15½-in. blocks, and the other of 1½ × 10 × 16½-in. blocks. These blocks were laid as just described, with I-bar connections supported by metal uprights spaced 7½ ft. apart. Patent dry mortar was used for the joints. Each partition was given a ½-in. coat of plaster on each side.

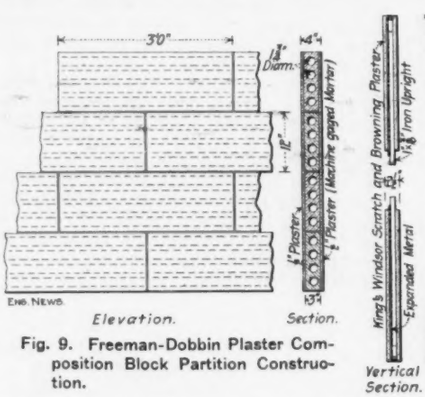


Fig. 9. Freeman-Dobbin Plaster Composition Block Partition Construction.

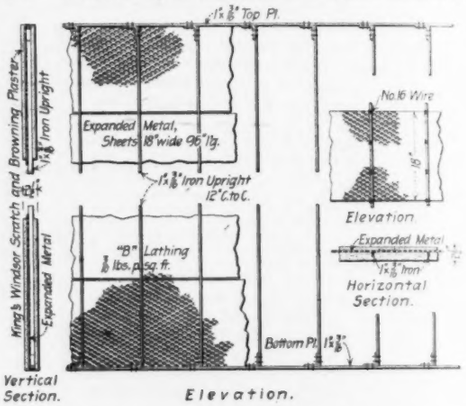


Fig. 10. Expanded Metal Lath Partition Construction.

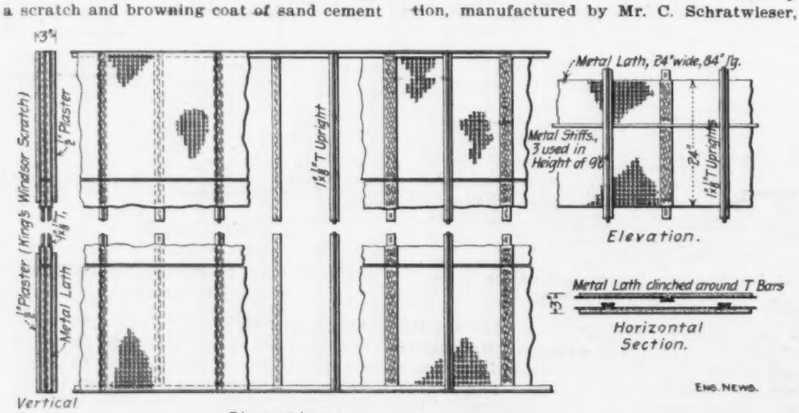
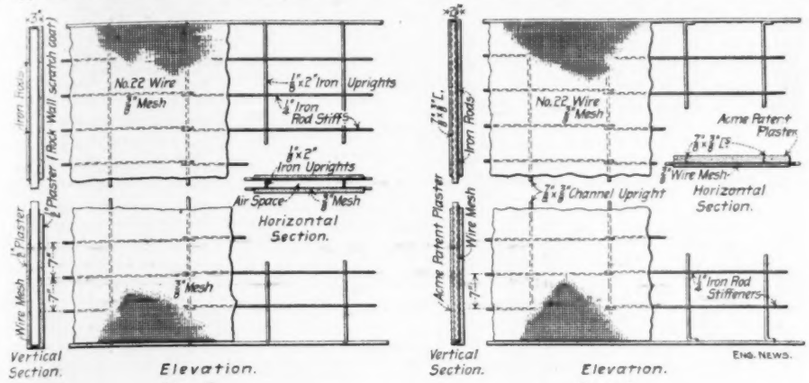


FIG. 11. MOESLEIN PERFORATED SHEET METAL PARTITION CONSTRUCTION.

The test was as follows: At 2.37 p. m. the fire was started, and at 3.14 p. m. the temperature recorded was 1,598° F. This temperature increased to [illegible]° F. at 3.20 p. m., and then decreased to [illegible]° F. at 3.32 p. m. Five minutes later water was applied for 2½ mins. on each partition. The was 1,760° F., and at 2.24 it was 1,850° F. From this time the temperature steadily decreased to 1,382° F. at 2.45 p. m. At 2.52 p. m. the water was applied for 2½ mins. to the east partition. The partition was examined on Oct. 1, and was found to have bulged outward about 1 in.* The inside



FIGS. 12 AND 13. ROEBLING WIRE LATH AND PLASTER PARTITION CONSTRUCTION.

effects of the test were examined on Aug. 28. It was found that most of the plaster coat had come off both partitions, but that the metalwork, except for a slight deflection in places, was intact, and that the blocks had suffered no injury from the fire and water. In no place had the fire passed through the partition.

On Sept. 30, a second Brinkman partition was tested, the construction of which is shown by Fig. 18. The partition was made of 2-in. solid terra-cotta blocks. The test was as follows: The fire was started at 1.52 p. m.; at 2.22 the temperature

plaster was washed away where the water struck and the mortar joints were partly washed away. In no place had the fire or water penetrated the partition.

CONCRETE BLOCK PARTITION.

SPRICKERHOFF PARTITION.—The construction of this partition, manufactured by Mr. George Sprickerhoff, Astoria, N. Y., is shown by Fig. 19. The composition of the blocks used was described as follows by the manufacturer:

Our block is composed of one part of Portland cement, one part of sand and five parts of steam ashes, and the blocks are laid in broken joints with cement mortar mixed in the proportions of one part of Portland cement to two of sand.

Interior and exterior were plastered with King's Windsor "browning" mortar. The total thickness of plaster, including finishing coat inside, was about ½-in.

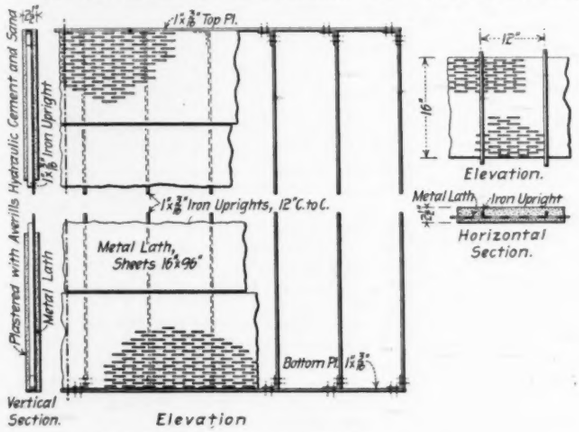
The test was as follows: The fire was started at 1.22 p. m., and at 1.37 p. m. the temperature was 1,112° F. This temperature gradually increased to 1,868° F. at 2.19 p. m., and one minute later water was applied for 2½ mins. The effect of the fire and water was to strip the plaster from the walls, but the blocks were unharmed and the partitions remained as straight and plumb as before the test began.

CONCLUSIONS OF THE BUILDING DEPARTMENT.

As the result of the tests described, Mr. W. W. Ewing, Engineer Building Department, reached the following conclusions regarding the Bell, Brinkman, Sanitary, Schratweiser, Sprickerhoff, Maurer, New York Expanded Metal Co., Moeslein and Roebling partitions:

I am of the opinion that these constructions can be used where the term "other fireproof material" occurs in the various sections of the Code for partitions, elevator shafts, dumbwaiter shafts, light and vent shafts and bulkheads on roofs, provided suitable separating bars or beams are used horizontally at each story height, in order to carry each story of elevator shaft or partition on itself; also, that partitions in their horizontal measurement shall be strengthened with such cross walls, piers or buttresses, or built, in such iron or steel framework as may be directed by the Department of Buildings. And further, in accordance with the former ruling in the case of dumbwaiter shafts, that they be built not over 45 ft. in height, without angle-iron construction at corners, and that all elevator construction shall have suitable angle irons at corners.

I would therefore respectfully recommend that the above



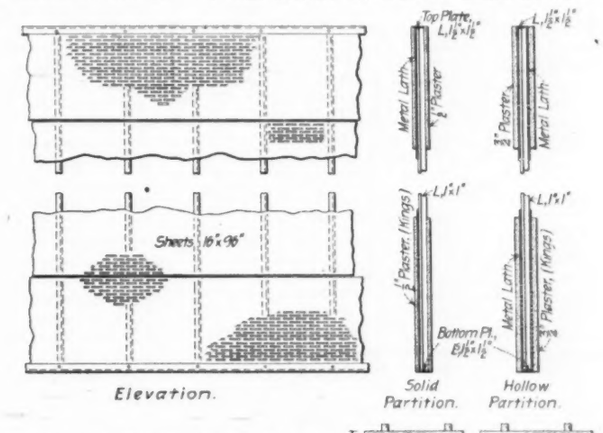


Fig. 15. Schratwieser Metal Lath and Plaster Partition Construction.

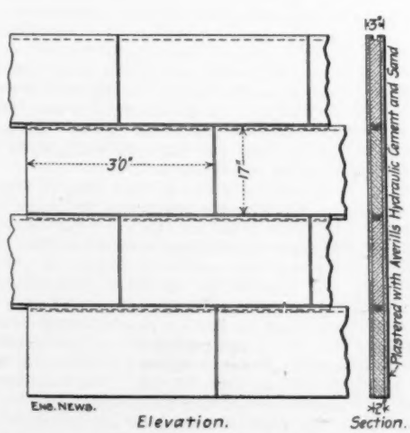
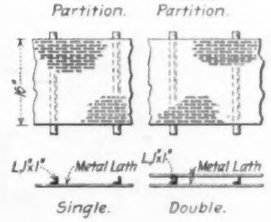


Fig. 14. Averill Plaster Block and Metal Lath and Plaster Partition Constructions.



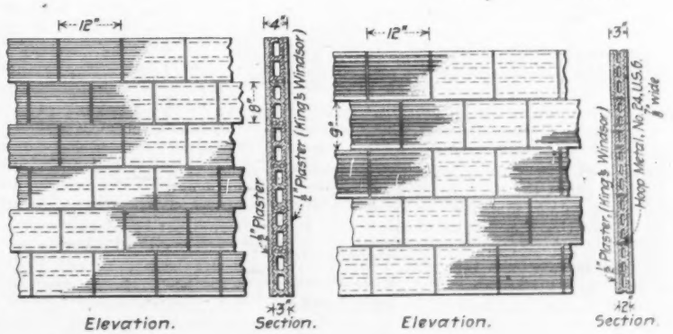


FIG. 16. HENRY MAURER & SON TILE BLOCK PARTITION CONSTRUCTIONS.

*The builder of this partition informs us that the bulge existed in the partition as constructed and was not caused by the test.—Ed.

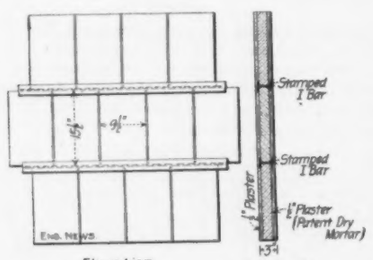
blocks (partitions) be allowed for use when constructed as tested, on condition that each story of partitions and elevator shafts be self-supporting, the partitions to be properly braced vertically, all elevator shafts to have angle-iron constructions at corners, and openings in same properly framed, and that the dumbwaifer shafts be not

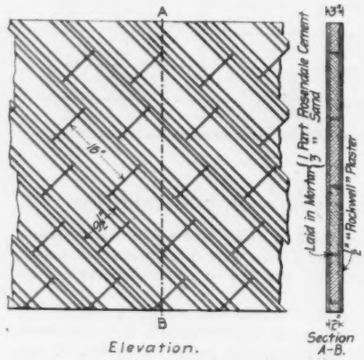
allowed to be built over 45 ft. in height without angle-iron construction, and that any variance or change in the composition or method of constructing said blocks (partitions) shall be declared to this department, in order that, if necessary further tests shall be made to demonstrate the efficiency of such new constructions.

Regarding the Norman, Metropolitan, Averill, Freeman-Dobbin and White partitions, the following conclusions were reached:

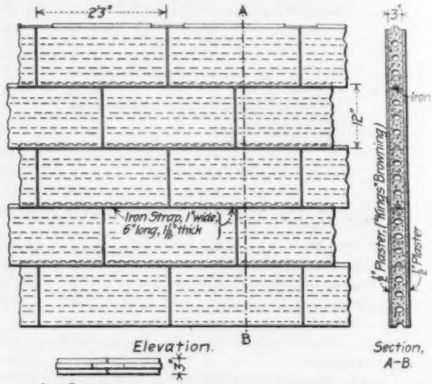
I am of the opinion that these constructions can be used where the term "other fireproof material" occurs in the various sections of the Code, for partitions, elevator shafts, dumbwaiter shafts, light and vent shafts and bulkheads on roofs, but not where prohibited in Section 37, Chapter 334, Laws of 1901, in relation to tenement houses, provided, suitable separating bars or beams are used horizontally at each story height, in order to carry each story of elevator shaft or partition on itself; also that partitions, in their horizontal measurement, shall be strengthened with such cross walls, piers or buttresses, or built in such iron or steel framework as may be directed by the Department of Buildings. And further, in accordance with the former ruling in the case of dumbwaiter shafts, that they be built not over 45 ft. in height, without angle-iron construction at corners, and that all elevator construction shall have suitable angle irons at corners.

I would therefore respectfully recommend that the above blocks (partitions) be allowed for use in buildings when constructed as tested, except where prohibited in Section 37, Chapter 334, Laws of 1901, in relation to tenement houses, on condition that each story of partitions and elevator shafts be self-supporting, the partitions to be properly braced vertically, all elevator shafts to have angle-iron constructions at corners, and openings in same properly framed, and that the dumbwaiter shafts be not allowed to be built over 45 ft. in height without angle-iron construction, and that any variance or change in the composition or method of constructing said blocks shall be declared to this department, in order that, if necessary, further tests shall be made to demonstrate the efficiency of such new construction.





FIGS. 17 AND 18. BRINKMAN TILE BLOCK PARTITION CONSTRUCTIONS.



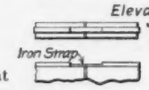


Fig. 19. Sprickerhoff Cement Composition Block Partition Construction.

THE FIELD PRACTICE OF RELINING RAILWAY CURVES.

By Howard C. Ives,* C. E.

In the early days of railroading little attention was paid to the monumenting of the right of way, especially at the P. C. and P. T. of curves. With lapse of time, on account of the relining of the track by the section foreman, and also by lateral shifting due to increase in weight of rolling stock, the curves get badly out of line and it becomes necessary to reline them. If the P. C. and P. T. are monumented it is an easy matter to set stakes on the curve, but when they are not it takes much more time in the field.

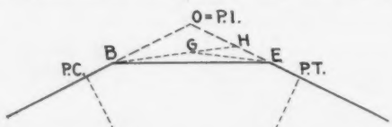
The number of cases arising in relining curves on existing track, unlike those cases arising in construction, fall in general under three classes. First, short curves where the tangents can be easily produced; second, longer curves where it is difficult to produce the tangents to intersection and where traversing is necessary; and third, very long curves where it is not advisable to traverse them. We will assume in each case that the notes of the original lay-out are at hand, or at least that we know the degree of curve, but that no monuments mark the P. C. and P. T. of the curves.

In the first case, the tangents should be produced to their intersection, and the intersection angle and the external distance measured and the degree of curve calculated and compared with the original notes. The degree of curve to the nearest whole minute should be taken and the tangent distance computed. The P. C. and P. T. in this case, as in the next, should always be set before any stakes are driven on the curve and the deflection angle from the P. C. to the P. T. checked. On a single track railway, where there is a long tangent adjoining the curve, a point is set on the center line between rails about 50 ft. from the P. C. The transit is then set up at this point, the distance between rails on the long tangents as far away as possible, is bisected by eye and this line produced backward to meet a line similarly found on the other side of the curve.

In case there is only a limited length between curves, a point on the tangent near the preceding curve must be found and used as a back sight and the tangent produced to meet the one on the other side. On a double-track road the center line between tracks is generally used. If, however, the distance between centers of track at the two ends of the curve is not the same, on account of spreading, to leave room for a bridge or other structure, a curve for each track must be run and in this case the P. C. and P. T. of both tracks should be monumented.

The second case is where it is difficult to produce the tangents until they intersect, and commonly given as the problem of locating a curve when the point of intersection is inaccessible.

In the figure, let B be a point on one tangent produced which is visible from a point E of the other. Measure the deflection angles at B and E and also the chord B E. The sum of the two angles will then be the intersection angle. Solve the triangle B O E for the sides B O and E O. From the original notes, which give the degree of curve, and the intersection angle = angle (B + E) calculate the length of the tangent and lay off the distances from the B to P. C. and from E to the



P. T., from or towards the P. T. (= 0) according as the tangent is greater or less than the computed sides of the triangle. In case the degree of curve is not at hand, the P. C. can be found by eye and the distance from B to this point measured and added to the computed side giving the tangent distance. Then the degree of curve can be found having the tangent distance and the intersection angle.

Curves of fractional minute, as 3° 31½', should not be used, and some roads even specify that only curves of even minute are to be employed, although cases arise, as shown later, where it would not be advisable to follow this rule rigidly. The reason why curves of odd minutes are not desirable is that with a curve of say 2° 5' and with 50-ft. chords used the deflection would be 31¼', which cannot be laid off with an ordinary transit only reading to minutes.

When E is not visible from B, another point as G should be selected which is visible from both B and E, and the two chords B G and G E, and the angles at B, G and E measured. The triangles G H E and B O H are solved, and the distances B O and O E compared with the computed tangent and the P. C. and P. T. set as before. By a careful selection of points it will seldom be necessary to solve more than two triangles. The chords should be carefully measured and the angles B, G and E doubled as a check. It is in this case after setting the P. C. and P. to run the curve around, setting stakes only the transit is to be set up, using flat sto intermediate stations and checking on th The curve can then be studied with res the track and the effects produced by shar or flattening the curve, before the final stak driven. After running the curve from the as far as possible, drive a stake at the last checking line and distance carefully. Then at this point, sight at the P. C., and deflect P. T. If the deflection is slightly off, for ex by three or four minutes on a long curve, the stake used as a transit-point should be shifted a trifle one way or the other until we check reasonably close on the P. T. This error is probably due to slight inaccuracies in setting the zeros and deflection angles, a very small error at the P. C. of the curve being greatly increased at the other end.

Particular care should be taken in checking on the back sight. The track target, similar to the one given by Tratman in his "Track and Track Work," page 324, was used by the writer. The cheaper target was used, a triangular form about 3 ins. wide by 4 ins. high, with a ½-in. point for driving into the tie. The target is driven into the stake back of the tack with its face towards the instrument. This is used as a back sight. The great gain by using these targets is in the saving of time required to run back to give sights.

After a sufficient number of curves have been re-run, the P. C., P. T., and points about five or six hundred ft. apart which were used as transit points, should be carefully monumented. In the future, when it is advisable to test the curves for line, it will only be necessary to set up over the monuments and re-run the curve, and there will be a great saving in time, since it will be unnecessary to produce the tangents to their intersection or to traverse the curve again. The monuments between the two end ones will greatly assist the foreman in keeping line.

When the curve is very long it will probably not be advisable to traverse the curve, but it will be better to set up at some point near the center of the curve and run in each direction, compounding whenever necessary to keep on the road bed. One case which the writer encountered was a curve about 7,500 ft. long, on which a 1° curve was used for 3,600 ft., and after this curve began to run off the road bed it was changed to a 59' curve. To keep the line anywhere near its present position on the road bed it was necessary to compound no less than six times.

The above cases are for simple curves less than two degrees. Where curves are over that degree some form of easement curve should be used and different classes of easements necessitate slight deviations in the field work. The good effect of using easement curves and of having curves in accurate line is generally appreciated by railroad men.

The methods above given were used by Mr. L. D. Stair, of Cleveland, O., and the writer in re-

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running the curves on the Eastern Division of the Pittsburg, Fort Wayne & Chicago Railway in 1899, under the direction of Mr. James A. McCrea, Engineer of Maintenance of Way at that time. Arrangements were made with the supervisors and one or two section men were picked up on the various sections to help out with the chaining and stakeholding. An average of about 2,200 ft. was relined each day with stakes 50 ft. apart.

JOHN LOUDON McADAM, THE ROAD-MAKER.

While the name of John Loudon McAdam, the famous builder of highways in England and Scotland, is as well known in the United States as in his own country, comparatively few American engineers remember that he spent a number of years in the city of New York, was first married in that city, and by a second marriage he was allied to

John Loudon McAdam.

one of our most prominent American colonial families. The London "Surveyor and Municipal and County Engineer," in a late issue, contains an extended memoir of McAdam, and from this we obtain the following notes of his life and the portrait here used.

John Loudon McAdam was the son of James McAdam, a landed proprietor of Ayr, in the southwest of Scotland, and one of the founders of the first bank in that town. He was born on Sept. 21, 1756, in Ayr, and was educated at the parish school; and at that time he is said to have indicated his inclination towards road construction by making a model of a road in the district. But his father died when John L. McAdam was 14 years of age, and the boy was sent, in 1770, to his uncle, William McAdam, a merchant in the city of New York. He there received his business training, and at the outbreak of the American Revolutionary War he became an agent for the sale of prizes taken in that war, and is reported to have made money out of the venture. On the declaration of peace, in 1783, however, as an adherent of the King of England, he found his surroundings uncongenial, and he returned to Scotland, a very poor man.

While in New York he married Gloriana Margaretta, daughter of William Nicoll, of Islip, Suffolk Co., Long Island; and after the death of this lady in 1827 he married Anne Charlotte de Lancey, sister of Bishop Wm. H. de Lancey, of New York. By his first wife he had four sons and three daughters.

For some time after his return to Scotland he resided at Moffat; he was for thirteen years a member of the Commission of the Peace and Deputy Lieutenant of the county; and during the Napoleonic wars he raised a volunteer corps of artillery for the defense of the coast, and was commissioned as a major in the militia.

During this period he was trustee on certain highways, and he then began to consider a scheme for their improvement. Though little is known of his earliest work in this direction, he experimented at his own cost and in the face of much prejudice on the roads in his jurisdiction, and he succeeded in improving them. The time was ripe for an attempt of this sort, for previous conditions had been so bad that in 1754, or about the time John L. McAdam was born, the newspapers announced that "a flying coach, however incredible it may appear, will actually, barring accidents arrive in London in four days and a-half after leaving Manchester."

The Highland Rebellion of 1745 had given a great impetus to road-making in Scotland, though these roads were chiefly for military purposes, utilized for keeping open communication between principal towns. But with this start it is recorded that between 1760 and 1780 no less than 600 Turnpike Acts were passed; the roads actually built under this authority, however, were constructed as a rule without system or technical knowledge.

In 1798, John L. McAdam took up his residence in Bristol, England, and he was engaged in some business connected with the victualling of the navy. While his official connection with road-work ceased for a time, his enthusiasm continued to grow, and he spent much time in traveling about the kingdom in the investigation of roads and the various methods of construction and repair then in operation. By August, 1814, he states that he had traveled 30,000 miles, and had expended in this work from his private resources a sum equal to $25,095. The experience thus gained made him a recognized authority on road-building, and his advice was eagerly sought by those having charge of roads. His views were boldly expressed, in print and before Parliamentary committees.

The first recorded practical application of his knowledge, on a large scale, followed his election as a trustee of the Bristol Turnpike Trust. He found the roads of that district in a very bad condition; and on Jan. 16, 1816, he was appointed surveyor for the trust, in direct charge of construction and repairs. His salary was at first $2,000 per year, and later $2,500; but out of this sum he had to pay his traveling and other expenses, amounting to about $1,000 per annum. The roads under his management aggregated 149 miles in length, but this was later increased to 178 miles. In June, 1817, he was enabled to report that none of the roads in the Bristol District were in a bad condition; the cost of maintenance had largely decreased; the income had increased in proportion; a floating debt of $7,000 had been paid off, and the principal debt had been reduced by $3,650.

Though he was surveyor to the Bristol Trust, it is evident that this work did not engage his whole time, for, by 1819, he had been consulted by 34 different bodies of road commissioners, representing 13 counties. In 1823, he had reported to 70 sets of commissioners in 28 counties; and of these the roads in 32 trusts were being managed by Mr. McAdam and his sons; according to the system devised by him and the work done by men trained under him. To Mr. McAdam's credit it must be stated that he received no compensation for this extra work, other than his traveling expenses; and in the cases where the road trusts were very poor he did not even receive his expenses.

The opposition to the McAdam system of road building was formidable, at first. The chief objections were—That the ramming of the bed was unnatural and ineffective, and was damaging to the wheels of vehicles and to the feet of the horses. As to the latter objection, the critics failed to remember that previously to the improvement of roads on the McAdam system the average life of a coach-horse was only three years.

In 1817, McAdam put down the first piece of macadamized road in London, by improving the approaches to Blackfriar and Westminster bridges. George IV. took a strong personal interest in the improvement of London streets; and this fact probably induced McAdam to leave Bristol in 1823 and take up his residence at Hoddesden, on the Great North Road, and a few miles from London. In this same year, 1823, he succeeded in getting an inquiry before a committee of the House of Commons as to his system, and he had constructed a full set of road-making implements, so that he could better explain the principles of his method. As a result the merits of macadamized roads were publicly admitted and acknowledged, and Parliament voted, first, $10,000, and later raised this to $40,000, to compensate him for the money he had personally expended in bringing his system into practical and general use. He declined a baronetcy, owing to his advanced years and small means; but in 1827 he was appointed Surveyor General to the Commissioners of Metropolitan Turnpike Roads, and his system was adopted throughout the kingdom.

At this time Mr. McAdam seems to have had a house at Moffat, Scotland; and in 1836 he removed from Hoddesden to Moffat, where he died on Nov. 26, 1836. He was buried in the Moffat churchyard, where also lies his wife, Anne Charlotte de Lancey, who died at Hoddesden on May 29, 1852.

The third surviving son of John Loudon McAdam, James Nicoll McAdam, of Turdon End, Essex, was Deputy Lieutenant of Middlesex in 1848, and Surveyor-General of Metropolitan Turnpike Roads. This son was knighted by King William IV. on March 26, 1834, out of compliment to the father—then living—who had declined a similar honor.

LONG SPAN MASONRY ARCHES ON THE NEUSTADT & DONAUESCHINGEN RY., GERMANY.

A new line of railway has just been completed from Neustadt to Donaueschingen, in Germany, about 47 miles. The road is located on a maximum grade of 1%, and has five tunnels aggregating a length of 4,028 ft., and three stone arch bridges of considerable span. These bridges are built with transverse spandrel arches, which carry the roadway and transfer the load to the arch ring at definite points (except for a short distance at the center of the span, where, owing to small total depth, the roadway rests directly on the arch ring). The longest single span of the three is that of the bridge over the Gutach River, with 210 ft. clear span and 52.5 ft. rise. The next in order of span length, the bridge over the Schwaendeholz Brook, near Cappel, with a clear span of 187 ft. and a rise of 55.8 ft., is the most interesting of the three on account of its being situated on a curve in the alinement of 2,620 ft. radius.

Long Span Masonry Arch Bridge, Neustadt & Donaueschingen Ry., Germany.

The accompanying figure shows this bridge. The principal figures relating to the construction of the central arch span are as follows: Width of arch, 14.4 ft.; thickness of arch ring, 6.56 ft. at crown, 9.18 ft. at springing; inclination of exterior faces of arch, 1 in 30. The material of the arch is sandstone from Zabern; the mortar used was cement mortar mixed in the ratio of 1 to 3. The arch itself was built in two thicknesses or layers, which were toothed 12 ins. The voussoirs of the lower thickness were laid together dry, and the joints were then rammed with mortar.

The total cost of the bridge was $62,160; the cost of the masonry was $11.85 per cu. yd., while the falseworks, etc., cost $20,000. The accompanying illustration is reproduced from the "Centralblatt der Bauverwaltung," to whom we are also indebted for the above data.

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The German "Society for the Study of Electric High Speed Railways" has issued a statement to the European technical press as to the results accomplished in its experiments, which we have from time to time noted. According to this statement the speed of their experimental car has been increased to a maximum of 160 kilos. per hour (= 100 miles per hour), which speed was reached with a line-pressure of over 10,000 volts. The operation at this speed is, however, considered somewhat dangerous with the present condition of the track. Further study will for the present be carried on at the "conservative" speed of 140 kilos. per hour (= 87 miles per hour). The statement is added that the highest speed ever yet attained on European steam railways has been 130 kilos per hour (= 81 miles per hour), and that 140 kilos. per hour (= 87 miles per hour) is the highest speed ever recorded on an American railway. One or two of our foreign exchanges, we notice, refer to this rate of 160 kilos. per hour as "the highest speed at which any human being has ever traveled through space."

If the German experimenters and editors will visit the United States they can find quite a number of "human beings who have traveled through space" on American railway trains at higher speeds than any which the German "high speed society"—to abbreviate its name—has thus far recorded. If our German contemporaries will refer to "Modern Locomotives," published in 1897, they will find a table of fast runs, from which we take the following:

July 26, 1900, Philadelphia & Reading Ry., Skillmans, N. J., to Belle Meade, N. J., distance 4.1 miles; time, 2 minutes 30 seconds; speed 100 miles per hour (= 160 kilos. per hour).

May 19, 1893, New York Central & Hudson River Ry., Looneyville, N. Y., to Grimesville, N. Y., distance 5 miles; time, 3 mins. 0 sec.; speed 100 miles per hour (= 160 kilos. per hour.)

May 9, 1893, New York Central & Hudson River Ry., near Grimesville, N. Y., distance 1 mile.; time, 0 min. 35 secs.; speed, 102.8 miles per hour (= 165 kilos. per hour).

These records are all well authenticated. A somewhat less certain record was made only two days after the last mentioned, on May 11, 1893, at the same place. The mile was said to have been run in 32 seconds, which would mean a speed of about 112 miles per hour (180 kilos. per hour). All the runs mentioned were made by engines hauling regular trains, those on the New York Central being made by the famous Empire State express.

Record time was also made in one or two instances on the Pennsylvania R. R. by a train running between Camden, N. J., and Atlantic City, N. J. The distance of 58.3 miles on Sept. 11, 1899, was made at an average rate of speed of 67.2 miles per hour, including stops. The detail figures at the points of maximum speed are subject to some uncertainty, but carefully verified figures show an average speed between East Hammonton and Absecon, N. J., a distance of 7.8 miles, of 93.5 miles per hour. Higher speed was stated to have been reached at Germania, N. J.; according to a statement of the superintendent of the line "the top speed appears to have been reached at Germania, which station was passed at a rate of speed exceeding 100 miles per hour, the times, according to the train register, showing a speed of 108 miles per hour between Egg Harbor and Germania, distance 2.7 miles, and considerably faster than that between Germania and Pomona." These latter figures, however, are subject to some uncertainty, as before mentioned.

In comparing these American records with the German experimental speed, it must be borne in mind that the American records were all made by regular passenger trains which could hardly be classed as light. The latter were made by a single experimental car, especially designed to reduce air resistance and other adverse factors to a minimum. The American records, further, were made over regular track used by all other classes of passenger traffic, and on divisions of considerable length compared with the 14 miles of the German experimental track

Further, any and all the locomotives which made this speed were designed to haul heavy passenger trains behind them. If anyone desires to operate a train schedule at speeds of 80 to 100 miles per hour or even more and is willing to run such light cars as those which the German experimenters are using, there are plenty of American locomotive designers who can produce a machine to meet the requirements.

THE REPORT OF THE ISTHMIAN CANAL COMMISSION.

Two weeks ago, in discussing the prospect of Nicaragua Canal legislation, we remarked that the present Congress is in a better position to act than any preceding Congress has been, since it has before it the final report of the Isthmian Canal Commission.

The text of this report has just been printed and forms a volume of 263 pages.* This does not include numerous appendices, maps, etc., which have not been printed and very likely will not be. To attempt to present to our readers any abstract or summary of the report as a whole is quite beyond the limits of our space, and is indeed hardly worth while in view of the Commission's preliminary report, presented a year ago, the substance of which was printed in our issues of Dec. 20 and 27, 1900. In the present article, therefore, we shall confine ourselves to a few features of the report which are of special interest at the present time.

NICARAGUA VS. PANAMA.—When the law was passed authorizing the appointment of the Commission, there was a general public sentiment that more authentic information was needed before anyone could fairly say which route the United States should adopt. Alleged information there was in abundance, but it was colored so much by the interest of rival syndicates and corporations that no man could say where the truth really lay. The Commission has made a most judicial and able comparison between the two routes, and its final recommendation of the Nicaragua route will receive general approval and will almost to a certainty be carried into effect by Congress. The Panama interests have been treated with the utmost fairness. The fact is, of course, that if the United States adopts the Nicaragua route, the Panama enterprise is completely and finally ruined, and all the millions which have been sunk in it become a total loss. It would ill become a great nation, however, to take advantage of such a situation to beat down a price. It can and should pay the fair value of what it buys. The Commission has made a careful estimate of all the work which has been done at Panama which would be useful for the construction of such a canal as they planned for that route. They used in this estimate the same unit prices that they used in all their other estimates on the isthmus and they added to the total thus found the value of the Panama R. R. and all other existing property of the Panama Co. which would be of value to the United States. The total thus found amounts to $40,000,000.

Of course, the Commission had no authority to offer this or any sum to the Panama company. Its duty was solely to ascertain the relative advantage of the two routes.

It was for the company to say what price it would take. It was the Commission's business only to ascertain this price and submit it in its report, together with such information as would enable the President and Congress to judge whether to accept or reject the offer. But the task of worming a definite business-like offer in dollars and cents out of the Panama Co., appears to have been about the most difficult which the Commission encountered. The plain question "What sum will you take?" was one which President Hutin evaded and postponed and parried like the keeper of an Oriental bazaar. In fact he was never brought to the point of making a definite offer; but when finally cornered he did submit a letter which it would take a Philadelphia lawyer to construe; but which the Commission in default of anything better, interpret to mean that his company will take $109,141,500 for all it holds on the Isthmus.

As we read the correspondence, President Hutin appears to have carefully left doors open on the one hand to raise his price, in case Congress showed a disposition to accept it, and on the other to come rapidly down in case it did not. Under such circumstances the Commission and Congress as well is entirely justified in paying no further attention to the Panama enterprise.

Published reports from Paris on Dec. 21 state that President Hutin has resigned, but his withdrawal comes too late to save the Panama Co. His stupid delusion that the Nicaragua route was impracticable, and that the United States would finally pay his price for the Panama works, will probably cause the work done at Panama to be a total loss.

We have given above the Commission's estimate of $40,000,000 as a fair value for the Panama works thus far executed. There is another standard by which to fix its value to the United States. It will cost $189,864,000 to construct a canal at Nicaragua; it will cost $144,233,000 to finish the works at Panama. If the two canals were of equal value when finished, then, the United States could afford to pay about $45,000,000 for the Panama works, or about the price which the Commission has estimated as their value. Had the Panama company made a square offer to accept say twenty or twenty-five million dollars for their works, it would have been a much more difficult task for the Commission to make a final choice, in weighing the relative advantages of the two routes. The time for such an offer, however, we believe, is now passed. The whole body of public and official opinion is so thoroughly committed now to the Nicaragua route that the Panama officers can hardly secure a further hearing. In the House, Mr. Hepburn's bill for the Nicaragua route has been made the special order for Jan. 7, and its passage appears a foregone conclusion. Action in the Senate will doubtless be more or less delayed, and probably the bill that body will finally pass will differ in many respects from the House bill. We look for no radi-

*The volume is issued by the Government Printing Office and is known as "Senate Document No. 54 of 57th Congress, 1st Session." Those of our readers desiring to secure a copy should address their Senator or Member of Congress, or the Superintendent of Documents, Washington, D. C.

cal differences, however, that a conference committee cannot adjust.

THE ADOPTED ROUTE.—As indicated in its preliminary report a year ago, the route fixed upon by the Commission for a Nicaragua Canal follows in general the line surveyed by the Nicaragua Canal Commission of 1897. The old Menocal high-level route, with the great dams at Ochoa and La Flor, the long line of embankments in the San Francisco basin and the huge divide cut, 8 miles long and 350 ft. deep at the highest point, is entirely abandoned.

The canal will begin at an artificial harbor formed between two projecting jetties two miles long, located about 1¾ miles northeast of Greytown. From this point it will run southwest through a low swampy country to the first lock, a distance of 9½ miles. Thence the line runs through a somewhat broken country 11 miles further to the valley of the Rio Negro, where the second lock is located. The lift of the first lock is 26½ ft. and of the second 18½ ft.

From Lock No. 2, the line runs west and crosses three high but narrow ridges to Lock No. 3 in the valley of the Danta, a tributary of the San Juan. These ridges involve the deepest excavation on the line. In the Tamborcito ridge the cut will be 292 ft. at the deepest point. It is only 3,000 ft. long, however, and the crest is narrow. The distance between locks No. 2 and 3 is 16.75 miles, and the estimated cost of construction is over $19,000,000.

From Lock No. 3 to Lock No. 4 is less than three miles, but located in rather rough country. Lock No. 4 raises the canal to its summit level, but a channel has to be made from it to the San Juan, a distance of about five miles.

As many of our readers will remember, a feature embodied in every Nicaragua Canal project since 1885, has been the damming of the San Juan River, so as to convert its upper reaches into an arm of Lake Nicaragua with a navigable depth of water. This dam at the same time makes it possible to use the entire area of that great body of water for storage purposes, to ensure a supply of water to the canal during the dry season. Mr. Menocal located such a dam at Ochoa. The Nicaragua Canal Commission of 1897 discarded the Ochoa site and chose one a little further up stream at Boca San Carlos. More complete borings have shown unfavorable conditions at this site as well, the rock lying in places as low as 120 ft. below water level. A new site has therefore been selected at Conchuda, where the greatest depth to hard rock has been found to be only 82 ft. The Conchuda dam is to be formed below low water of caissons placed close together and sunk to bedrock by the pneumatic process with the joints between them sealed. Upon the platform thus made the rest of the dam will be built as a continuous monolithic structure. Besides the central portion of 731 ft. to be built in the manner above stated, an extension 100 ft. farther on each side will be built in open excavation. Core walls extend 100 ft. farther on one side and 240 ft. on the other making the total length of the dam 1,271 ft. The cost is estimated at $4,017,000.

It is estimated that this dam can be built in four years, whereas eight years was the time estimated for the dam at San Carlos.

The Conchuda dam is located nearly 50 miles from Lake Nicaragua. To deepen and straighten the river channel from the dam to the lake and do other necessary work on this section will require about $23,000,000.

Next comes the distance across Lake Nicaragua, 70 miles, of which about 40 miles is in deep water and the remainder will require more or less dredging. The total expenditure on this section is put at $7,000,000 in round numbers.

From the lake the canal line follows the valley of the Las Lajas and a tributary till it pierces the continental divide which is passed at a point 5 miles from the Lake. At this point the canal excavation will be about 85 ft. in depth. Thence the line passes down into the valley of the Rio Grande and the first drop toward the Pacific is made at Lock No. 5, located nine miles from the Lake. The cost of this section is estimated at nearly $20,000,000. From this point the line follows the Rio Grande to the Pacific terminus at Brito, dropping 28½ ft. at Locks No. 6, 7 and 8. The total distance from Lake Nicaragua to the 6-fathom curve in the Pacific is 17.34 miles.

The time required for constructing the canal is fixed now, not by the dam across the San Juan but by the length of time required for excavating the cut through the Continental divide west of the Lake. This contains about 18,000,000 cu. yds. and it is estimated that it could be excavated in four years. The Commission, however, believes that for letting contracts, assembling a force of laborers, getting machinery on the ground, making a temporary harbor with 18 ft. depth of water on the Atlantic terminus and building a double-track railroad along the route from end to end at least four years more would be required.

These works, it will be appreciated, cannot be carried forward simultaneously. A harbor on the Atlantic coast where vessels of moderate draft could discharge men and machinery must be built first of all, and following that a railway must be built from end to end of the line. It will then be possible to transport building material, machinery, etc., to the various sites where work is to be undertaken; but the delays incident to this preparatory work in a tropical country far removed from the base of supplies make a liberal estimate for the time required very wise.

Comment on some further features of the report we postpone to our next issue.

THE FIRE-RESISTING EFFICIENCY OF FIREPROOF PARTITIONS.

The partition is the weakest detail of structural fireproofing in modern fireproof building construction. This may seem a bold assertion, but a brief study of the records of fires in fireproof buildings will, we think, demonstrate that the statement is fully warranted. It is a well-known fact that in every severe fireproof building fire of which there is any authentic record the partitions have suffered more severe injury from fire and water than any other part of the structural fireproofing. It is also true that, notwithstanding this experience, the partition has received less study and investigation from engineers and architects than almost any other item of structural fireproofing.

These facts lend unusual interest to the series of fire and water tests of fireproof partitions which has recently been conducted under the supervision of the Department of Buildings of New York city, and the results of which are recorded in another part of this issue. In passing it is not out of place to remark that, with the exception of a few isolated tests conducted by interested parties, these are the first comprehensive partition tests ever made. The fact that these tests were deemed desirable makes it appear likely that a brief consideration of the efficiency of fireproof partitions in general may prove of interest.

Partitions in fireproof buildings subserve two principal purposes. First, as screens erected to subdivide floor areas into rooms, halls, corridors, etc., or to enclose shafts and stairways, they perform a purely architectural function. Their second purpose, as a part of the whole scheme of fire-resisting construction, is to localize fire in the architectural subdivision in which it originates. It is evident that these two functions of the partiton, the architectural function and the fire-resisting function, are to a certain extent mutually exclusive. To serve the architectural purpose for which they are designed partitions must have door, and, perhaps, window openings, and these openings detract from the fire-resisting qualities of the structure directly in proportion to their number and size. At best, therefore, partition construction in fireproof buildings is a compromise between two sets of mutually exclusive conditions. Finally, partition design, considered as a part of the whole scheme of fireproofing, involves problems of fire-resisting arrangements of partitions as well as the problem of their individual structural resistance to fire.

The foregoing general truths are all self-evident, probably, to every engineer, but they are so frequently overlooked or neglected that it seems desirable to develop one thought further. As already stated, a fireproof partition construction must meet the conditions of architectural service in securing a convenient subdivision of areas, and the conditions of fire-resisting service in limiting the spread of fire. To meet these conditions efficiently the partition must possess heat retarding qualities to prevent the transmission of a dangerous amount of heat by radiation to adjoining areas; stability against the shock of hose streams or other physical forces which may reasonably be expected, and sound-deadening qualities to prevent the transmission of noise. Finally, the partition must supply these requirements by employing a cheap material easy to obtain and light in weight, and without occupying excessive space on account of its thickness. We will repeat again that these propositions are self-evident, and in a large degree elementary. Nevertheless, their requirements must be satisfied by every partition construction which can justly claim the consideration of architects and builders of fireproof structures. The question before us now is: To what extent does modern fireproof partition construction satisfy the requirements so far laid down?

In considering this question it will prevent confusion if we assume for the present that all the partition constructions in use are on a parity in respect to the efficiency with which they meet the requirements of architectural service. This leaves us only the question of efficiency in fire-resisting service to consider. The behavior of fireproof partitions in actual fires and in artificial fire tests furnish us the only valid evidence we have upon which to base an answer. So far as the evidence from actual fires is suggestive it shows that the partitions used have been, practically, failures in confining fire. It also shows that this failure has been generally due to the burning out of the door and window framing and of the wooden base boards, which has deprived the remainder of the structure of its support, and either overthrown it or rendered it so unstable as to be easily overthrown by hose streams. The failure has not been due to the lack of fire-resisting and heat-retarding qualities in the wall construction itself. Instances can, of course, be cited which do not bear out this conclusion, but it will be generally agreed by those who have followed the records carefully, we think, that the majority of the available evidence supports it.

Turning now to the evidence afforded by artificial fire tests, we have practically only the series of tests described elsewhere in this issue to consider. Altogether nearly a score of partitions were tested in this series. The types of construction represented were: Metal lath and plaster, terra cotta block, plaster composition block and concrete block. The tests, therefore, covered practically all the general types of fireproof partition construction now in use. As will be seen from the description of the tests, which we publish, the Engineer of the Building Department has not seen fit to make individual comparisons of the behavior of the different partitions, or, even, of the different types of partitions. This was doubtless the safest attitude to assume, and the critic is certainly courting trouble when he attempts to go further. Nevertheless certain broad facts stand out with such prominence that to neglect to mention them is to fail in drawing out the full value of the tests. We shall, therefore, call attention to some notable features of the published results.

The fact which strikes one first, perhaps, is that in no case, except in one partition of experimental construction, did either fire or water pass through the partition, and in no case did a partition transmit a dangerous amount of radiated heat. When we compare this result with the general failure of similar partitions in actual fires it seems at first sight difficult to reconcile the two. Really, however, the two results agree quite closely when we consider the different conditions governing the two cases. The partitions employed in the Building Department tests were in all cases unbroken by doors or windows, and they were of comparatively small area. Furthermore, no wood whatever was used in their construction; the bases of the partitions in all cases rested directly on the brick dwarf wall of the test house, or else on steel members, which themselves rested directly on the brick wall. The result of this construction was that there were no wooden base boards and no wooden door and window frames to burn out and reduce the lateral stability of the solid wall portion, and, as stated above, this has been

the chief cause of the disastrous partition failures in actual fireproof building fires. We may assume, without much fear of contradiction, that any of the types of partition construction named above will successfully prevent the passage of flame or of a dangerous amount of heat through the solid wall portions of the structure so long as these portions are not rendered structurally unstable by the burning out of their supports.

The lesson of this conclusion will be considered later, and attention will be turned to one or two other items of structural efficiency which are indicated by the tests. Referring first to the plaster composition block partitions, it will be observed that in every case a portion of the plaster block washed away and disappeared under the action of the hose stream. In the solid blocks the depth of the injury reached from ½-in. to 1¼ ins., and was in most cases nearer to the former dimension than to the latter. Where the injured portion of such a partition is small in area and the injured material does not extend deeper than ½-in., the circumstances in most cases would probably warrant the partition in being reused by simply repairing it with an extra thick coat of plaster. Were the blocks injured to a greater depth it would, however, be doubtful practice to do this. The reason for this is that plaster cannot be depended upon to keep its bond under the attack of fire and water, as was completely demonstrated in the tests, where the very best wall plasters failed to hold to the partition blocks. To reuse blocks cut down to approximately one-half their original thickness by fire and water, with no better protection from further attacks by the same elements than a surface coating of plaster, which would quickly peel off, would, we think, be held by most engineers to be poor practice. In the case of hollow plaster blocks the impossibility of reusing the original blocks is even more pronounced, as the tests clearly demonstrated. In the two instances in which cellular plaster block partitions were tested the inner shells were washed away so as to expose the hollow interior. To replace entirely the injured blocks seems to be the only justifiable method of repairing the partition in such cases.

In the metal lath and plaster partitions, which were tested, the amount of structural injury resulting from the fire and water was in most cases very small, if we assume, as is commonly done, that the plaster element of such constructions is to be considered simply as a covering such as it evidently is in the case of block partitions. It seems doubtful if this assumption is entirely justified, however. The test of this conclusion, to our mind, lies in the following facts. Were all plastering omitted from a block partition it would still serve all the practical purposes of a partition, but if the plastering be omitted from a metal lath and plaster partition the structure remaining is simply an open framework of metal, and not a partition in the ordinarily accepted sense of the term. To return to the results of the test, however, it will be seen that so far as observed no serious injury resulted to the metal element of the structure in any instance. In every case the inside coating of plaster which received the direct attack of the fire and water was more or less completely destroyed. As a partition the structure was, therefore, as the result of the attack of fire and water, in a seriously damaged condition, but, also, in such a condition that by replacing the damaged coat of plaster the structure could be made practically as sound as ever.

The partitions of terra cotta blocks and of concrete blocks are the last to call for attention, and in one sense they call for the least attention, for the effect of the fire and water upon them may be summarized in the following brief words: The inside coatings of plaster were partly destroyed, but the partitions had suffered absolutely no other injury.

Comparisons are odious, always, if we may believe the old saying, and in cases like the present, where there are so many variable factors, they are certain to be particularly odious in some ways; nevertheless it is only by comparisons that we are able to arrive at definite determinations, and we shall venture upon them. As already noted, the four types of partitions stand on a parity in respect to their impermeability by fire and water. Two other broad bases of comparison remain. The first of these is the comparative difficulty and cost of repairing the damaged structures. On this basis the terra cotta block and the concrete block constructions rank the highest and the honors run about even between the metal lath and plaster and the plaster composition block constructions. The second basis of comparison is the relative conditions of the several types of partitions as they emerged from the tests on the basis of their ability to endure without repair a repetition of the same test. On this basis the terra cotta block and the concrete block constructions again rank the highest, and the plaster composition block constructions rank generally above the metal lath and plaster constructions. As we have already premised, there are other factors than those comprehended in these comparisons, which must be taken into account in determining the general efficiency of partition constructions, but these will not be considered here further than by the mention already made of them, since it is the purpose at present to discuss simply the fire-resisting efficiency of fireproof partitions.

Returning now to the consideration of the cause to which we have attributed the failure of fireproof partitions in actual fires, namely, the destruction of the lateral stability of the partition structure by the burning out of the window and door frames and the wooden base boards, it is worth while to study briefly the lesson which is taught by it. The facts are as follows: Both actual fires and artificial fire tests show that there is very little danger of fire or of a dangerous amount of heat passing through the solid wall portions of any of the better partition constructions; but actual fires have shown, moreover, in nearly every case, that fire will almost certainly break through wooden-cased windows and doors and destroy the solid wall portions by burning our their supporting framework. A certain remedy against this result would be to build partitions without doors or windows or wooden base boards. Obviously this remedy cannot be applied in its entirety. Partitions may very well be built without windows, and they should without question always be built without wooden base boards. but they cannot be built without doors. An equally certain remedy would be so to construct the window and door openings that they will be as efficient in resisting the attack of fire and water as is the solid wall portion of the structure. This remedy also is not possible of perfect attainment, more particularly in window construction, although an approach to it can be made by using wire glass. However, as we have stated, it should be possible to dispense to a large extent with windows in partitions. In fact, it may be questioned whether a design which requires them for adequate lighting can be considered successful architecturally. Window frames and door frames in partitions can, however, be made of metal, and metal-covered doors can be employed, and it seems doubtful whether the architect has any right to class a partition as of fireproof construction unless these things are done. It is doubtful, indeed, unless they are done if there is any real warrant for the expenditure necessary to make the solid wall portions of fireproof material. It is evident that these features of partition construction can be enlarged upon still further, but we shall leave the reader to do this for himself. The point that we wish to emphasize is that the problem of securing efficient fireproof partition construction has got beyond the point where a search is necessary for some material and method of construction which will produce a solid wall impenetrable by ordinary fires, and has reached the point where endeavor must be directed toward securing, first, a reduction in the number of door and, particularly, window openings, and, second, a construction which will make such openings of this sort as are necessary approximately as impervious to the passage of fire as are the solid portions of the partition.

LETTERS TO THE EDITOR.

A Good Record in Concrete Laying in Denver, Colo.

Sir: Referring to the amount of labor necessary for mixing and laying concrete, as given in Mr. Gillette's paper in your issue of Dec. 5, I wish to call attention to the amount of time consumed in this work on the Delgany sewer extension during the summer of 1894, Denver, Colo. The cost of laying 1 cu. yd. of concrete (shown (see page 110, Vol. 35, Trans. Amer. Soc. C. to be 70 3-10 cts. for a layer under the sewer 16 ft. and 8-ins. thick. The work was done by one gang at aver-age wages, including foreman, at $1.95 per day of hours. In other words, each cubic yard took 0.36 day's work—or 2.9 hours to lay, figured on actual wages paid not on wages of from 12½ cts. to 17½ cts. per hour reduced to per cent of a 10-hour day on a basis of 20 cts. per hour. As Mr. Gillette's best showing is 0.335 of a 10-hour day or 3.35 hours for concrete not thoroughly mixed, and his average is 0.45 of the same day, or 4.5 hours reduced from wages which were from 10% to 30% lower than his assumed rate of $2 per 10-hour day, it is, I think, evident that "working by the day for some municipality" is not always synonymous with being "half asleep" as one might infer from reading Mr. Gillette's article.

About 1,545 cu. yds. of concrete were laid on the Delgany sewer extension by men working by the day for the city. Yours truly. W. W. Follett.

416 Kittredge Building, Denver, Colo., Dec. 14, 1901.

Criticism of the Masonry Portion of the New Croton Dam.

Sir: The report of the board of engineers on the earthwork of the new Croton Dam is a step in a safe direction; indeed, a step in avoidance of an impending disaster of frightful magnitude. Unfortunately, this criticism and condemnation of the design does not go far enough; it should have included the section of the stonework, the dimensions of which are inadequate to provide against an important danger not considered in the design.

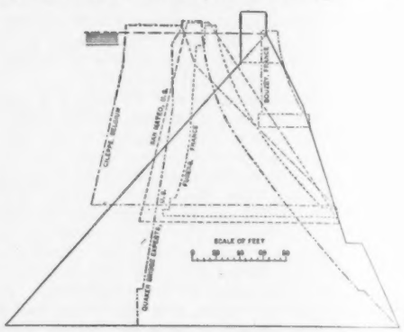


Fig. 1. Comparative Sections of Some of the Great Masonry Dams of Europe and America.

In the design of this section it was assumed that no dangerous percolation of water could possibly penetrate the foundations or masonry of the superstructure. It is, however, by no means a remote possibility that the water under the enormous head of from 200 to 300 ft. may work its way through the foundation or the masonry, and develop a lifting pressure of dangerous extent.

The board found, as was to be expected in all the important earth dams of the Croton shed, that the water percolated through the enormous banks of well-laid earth, and thick cores of the best-built masonry, with very small loss of head. They also found, as was already known, that the foundation was of soluble limestone and filled with fissures, seams and pockets:

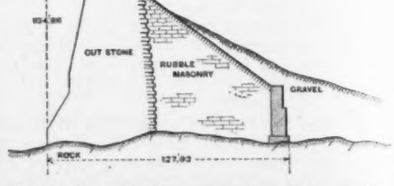


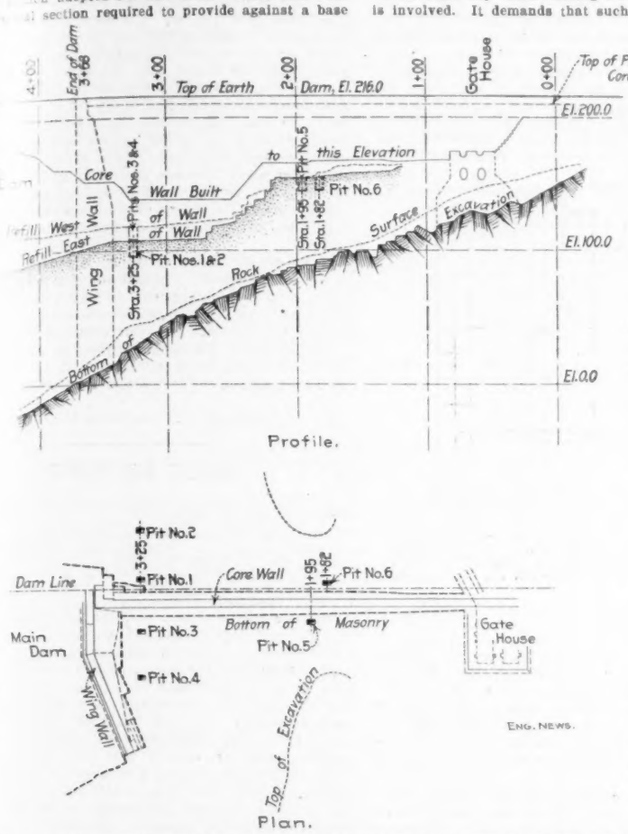
Fig. 2. Cross-Section of Lozoya Dam, Spain.

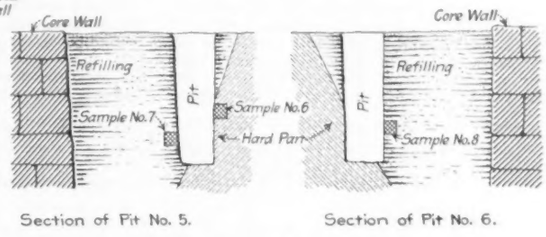
Another peculiarity of this construction is the character of the rock on which it is founded, which is shown by the history of the excavations made for the founding of the masonry dam and the core walls, to be a soluble limestone, having a vertical dip, and a strike following the valley and at right angles to the line of the dam, diversified with belts of varying width which were full of eroded seams and cavities, through which water flowed freely during the excavation, or masses of stone broken up by seams running in all directions, which were filled with mud.

Besides this there will be shrinkage cracks in the great mass of stonework, running in all directions, and of uncertain extent. Under these conditions does it not seem hazardous to adopt a section for the highest and most dangerously placed dam in the world, which does not provide for a base or liftng pressure of water, a section, too,

much smaller than that adopted for the important dams of Europe. The annexed sketch, Fig. 1, compares the sections of some of the greatest dams of Europe and America, with the section adopted for the Croton Dam, and with the theoretical section required to provide against a base penetration of water under pressure, under the bases. The sections in both cases were, however, properly designed for impervious foundations.

New York city cares nothing for economy, when safety is involved. It demands that such a work be made safe





Section of Pit No. 5. Section of Pit No. 6.

Descriptions and Analyses of Samples of Earth Taken from Embankment of New Croton Dam for Physical Tests by Hydraulic Laboratory of Cornell University.

Sample No. 1, Pit No. 1.—From sides of pit at depth of 9 to 12 ft.
" " 2, " " 1.—Taken at random from both sides of pit.
" " 3, " " 2.—From near the bottom of pit, west side.
" " 4, " " 1 & 2.—Taken at random from piles around the pits.
" " 5, " " 3.—From the sides near bottom of pit.
" " 6, " " 5.—"Hardpan," taken from natural bank on the west side of sheet piling, Station 1 + 95.
" " 7, " " 5.—"Made bank" taken from refill on east side of sheet piling, Station 1 + 95.
" " 8, " " 6.—"Refilling" or "puddle" taken from upper or east side of core wall, Station 1 + 82.
" " 9, Hillside about 100 ft. east of core wall, an excavation having been made in the natural bank to obtain a sample of "hardpan," representing material used for refill and puddling next to core wall on upper or east side.

Parts per 10,000 by Weight Retained on Screen After Samples Had Dried Several Hours at 250° F.

	Sample Number								
	1.	2	3.	4.	5.	6.	7.	8.	9.
2 meshes per lin. in	1,483	1,323	1,348	2,448	2,467	499	579	617	290
4 " " " "	945	592	757	561	728	295	535	538	309
6 " " " "	399	270	372	265	356	107	281	314	126
10 " " " "	679	478	585	482	544	206	377	566	234
20 " " " "	1,003	751	1,012	501	966	482	808	794	369
40 " " " "	1,696	1,328	1,585	1,430	1,785	552	1,520	1,620	796
80 " " " "	1,619	2,281	1,939	1,986	1,655	2,054	2,123	1,874	1,503
100 " " " "	713	1,105	1,069	707	688	1,596	1,149	1,021	1,733
130 " " " "	289	234	184	231	166	373	305	318	442
200 " " " "	493	448	389	629	338	1,195	920	819	1,597
Pass'g No. 200 screen	681	1,183	807	759	307	2,491	1,345	1,510	2,510
Total.....	10,000	9,993	9,997	9,999	10,000	10,000	10,002	9,991	9,999

FIG. 1. TEST PITS; DESCRIPTION OF SAMPLES AND RESULTS OF PHYSICAL ANALYSES OF SAMPLES OF EARTH, NEW CROTON DAM.
(This is a reproduction of Sheet No. 2 of the Appendix to the recent Experts' Report.)

or lifting water pressure. It appears that for the same height, the great Gileppe Dam in Belgium, has a section twice as large as that of the Croton Dam, and that the San Mateo Dam, in California, has a section over one-half larger. The Furens Dam has a section only slightly larger than the Croton section, but it is a short dam and arched with a comparatively small radius. The old Spanish Lozoya Dam, Fig. 2, has a section about as large as that of the Gileppe Dam. The great Vyrnwy Dam of the Liverpool water-works is another case, in which the engineers have thought it wise to provide a section large enough for safety against even remote dangers.

There have been at least two frightful disasters in the last six years from the slipping out of dams having sections inadequate to resist a lifting water pressure: The destruction of the Bouzey Dam in France, in 1895; and, last year, the failure of the Austin Dam. These dams were designed by able engineers for impervious foundations, but no provision was made in the dimensions of the sections for a base or lifting water pressure. These failures were clear cases of horizontal slipping, due to the

from the most remote danger which might result from the pressure of water contemplated.

John D. Van Buren, M. Am. Soc. C. E.

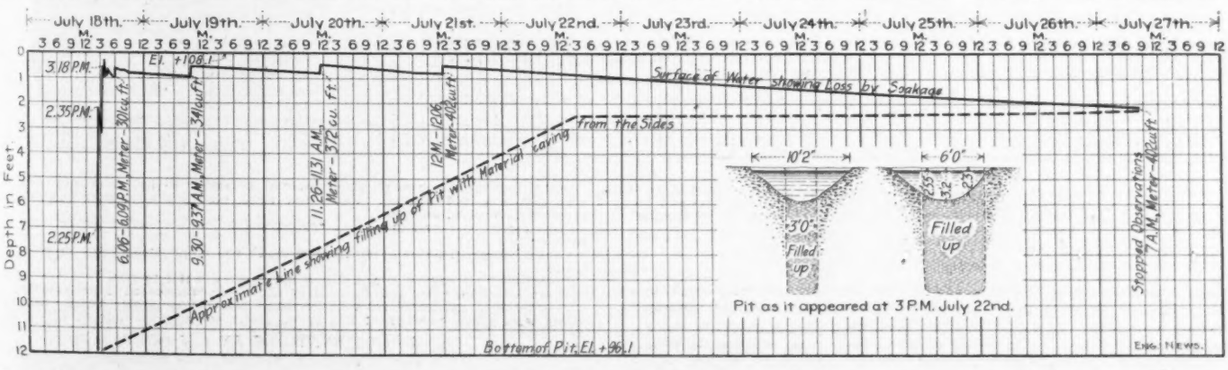
Newburg, N. Y., Dec. 4, 1901.

Mr. Sweet's Comments on Mr. Fteley's Reply to the Experts' Report on the New Croton Dam.

Sir: There are some statements in Mr. Alphonse Fteley's letter in your issue of Dec. 12, relative to the report to the Aqueduct Commissioners published in your issue of Nov. 28, about which I beg leave to say a few words.

The first statement to which I desire to call attention, is the assertion that our report does not give an exact idea of the conditions existing near the south end of the masonry dam where it is joined by the core wall, illustrated by Figs. 1 and 5 of the report. Unfortunately, Fig. 1, as reproduced by you, omitted the line of least resistance which is clearly shown on the original drawing. (See p. 455, of our issue of Dec. 12, for a reproduction of the plan, with the line included.—Ed.) These figures undoubtedly indicate the exact conditions at the south end of the dams as shown by the progress notes and levels of the work and are described minutely and accurately in the text of the report.

The inaccuracy of the statement that a section of the Titicus dam on a similar "line of least resistance" would compare unfavorably with this at the new Croton dam is obvious from Mr. Fteley's description of the height and slope of the Titicus excavation. The Titicus section would show a core wall and artificial embankment half as high, the embankment having flatter slopes, resting on earth and rock surfaces, also of flatter slope than at the new Croton dam, and with a core wall the same thickness at the base as that at Croton, which is twice as high. The assumption that this structure at Titicus, with dimensions not without precedents, furnishes a safe measure for predicting the behavior of one twice as high, designed with steeper slopes and a relatively thinner core wall, is clearly inadmissible. Mr. Fteley's letter infers that our experiments made to determine the suitability of the mixture of earths employed in constructing embankments for this dam were confined to the laboratory experiments made at Cornell University, while the appendix to our report contains the result of many experiments conducted by us at the dam site, some of the more instructive of which consisted in noting the effect of filling and keeping full



Dotted lines represent longitudinal and cross-sections of pit as excavated 11 ft. deep. Full lines and shading represent pit as it appeared at 3 p. m. July 22. Average depth, 2.4 ft. Material continually caving, caused by soakage and undermining of the sides and ends. This pit was not protected by planking and shoring. Started to fill pit at 2.10 p. m.; first six meter readings (cu. ft.) were as follows: 2.10 p.m., 0; 2.25 p. m., 100; 2.35 p. m, 200; 3.18 p. m., 260; 3.44 p. m., 276; 4.34 p. m., 285. See diagram for balance.

FIG. 2. OBSERVATIONS AT PIT NO. 1.
(12 ft. east of core wall; 6 × 3 ft., 3 ft. deep.)

of water pits excavated in parts of the embankment already made, the results of which are shown on sheets No. 2 and No. 3 of the appendix of our report, copies of which are enclosed.

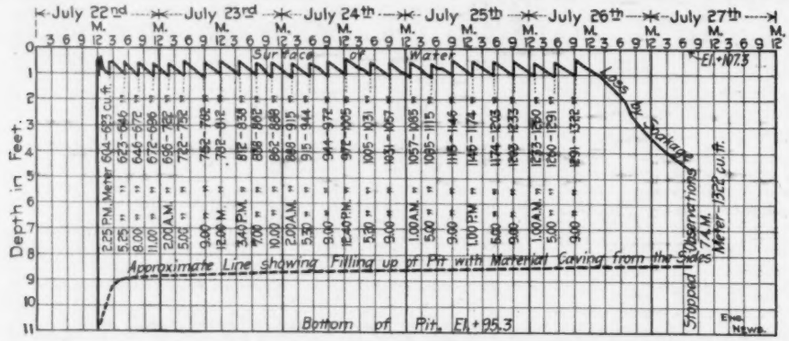
Pit No. 1, near the junction of the core wall and masonry dam (Fig. 1), when filled with water not only absorbed it rapidly, but immediately began to cave in, processes which continued until the pit, originally 11 ft. deep, was filled with earth to within 2.4 ft. of the surface, the earth assuming very flat slopes. As indicated on sheet No. 3 (see Figs. 2 to 5) similar results were observed at pits Nos. 2, 5 and 6, except that in pits Nos. 2 and 6, where the sides were protected by timber lining, the caving earth did not fill the pits so near the surface, but assumed flatter slopes, and pit No. 6 could not be filled with water to the top on account of leaks developing, one along the core wall breaking out on the slope 40 ft. north of the pit about 9 ft. below the surface of the refill, and another breaking out opposite the first leak, where the refill joins the hardpan excavation for the core wall trench and about 5 ft. lower down, or 14 ft. below the top of the refilling, both leaks discharging turbid streams down the slope to pits Nos. 1 and 2. The results of these experiments, and of the analyses of numerous samples of the materials found in this embankment, disclose so large a percentage of mechanically soluble earths as to forbid any movement of water through this earthen dam.

Upon this postulate is based the proposition in our report which Mr. Fteley seeks to controvert: "that the more compact the material of which the bank is built the steeper will be the slope of saturation." It is obvious that if the embankment below the core wall is built of material so compact as to be impervious to water, no water passing through the wall will enter it, and the slope of saturation will be vertical. If it be less compact, water will enter more or less according to the head or pressure, and according to its compactness or porosity, producing a slope of saturation whose inclination is dependent on the frictional resistance encountered by the water; and the bank will be tight wherever the slope of saturation remains within the figure of the embankment.

Mr. Fteley fails to distinguish between the slope assumed by water retained in an embankment, and that taken by water passing through an embankment made of material too porous to retain it; where the rule is clearly reversed and where the more porous the material the steeper the slope at which water will run through it at a given rate.

The borings made in the other dams in the Croton valley show that their exterior embankments retain the water of percolation and a study of the borrow pits from which they are made indicate material very similar to that of which the exterior embankment at the new Croton dam is being made. That leakage through the core wall will be extensive enough to test the retentive capacity of its exterior embankment there can be no doubt.

The leak developed by our experiment at pit No. 6 shows the readiness with which water finds its way along the face of the masonry and the great and continued settlement of the embankment 200 ft. high will tend to facilitate this process and make the water pressure from the reservoir effective upon the face of the core wall.



July 22—Notwithstanding the sides of this pit were protected with planking set 2 ins. apart, supported by 3 × 4-in. frames, the material of the refill soon commenced to disintegrate and cave in so that at 3 p. m. it had filled up to 2 ft. As often as water in pit fell 6 ins., the supply was turned on and pit filled up to top mark, 0.5 (approx.) Started to fill pit at 11.56 a. m., meter reading 402 cu. ft.; pit full at 12.17 p. m., meter reading 587 cu. ft.; 12.27 p. m., meter reading 596 cu. ft.; 12.42 p. m., meter reading 604 cu ft.

FIG. 3. OBSERVATIONS AT PIT NO. 2.
(50 ft. east of core-wall; 5.25 × 2.3 ft. × 11 ft. deep.)

The ineffective resistance of this core wall to leakage under moderate head was demonstrated when the embankment was being made about elevation 100, the refill on the west side of the core wall being carried 20 ft. or more higher than on the east or reservoir side, when the water used in consolidating the refill on the west side developed numerous leaks through the wall which is laid in native cement mortar.

This leakage through a wall 11 ft. thick under slight head, implies sufficient lack of compressive resistance in the mortar to create apprehension of greater settlement in the core wall 200 ft. high than in the dam masonry which it joins, the latter being under much less vertical stress, resulting in fractures and additional leaks.

The economy of design to which Mr. Fteley appeals as the guiding principle of the plans for this composite structure would have a more rigorous application in an earth-en dam from bank to bank with its spillway channel excavated in the rock, avoiding the risks we have pointed out, which are inherent in a composite structure of this magnitude, and involving, in my opinion, no greater risks or uncertainties.

Elnathan Sweet.

Albany, N. Y. Dec. 15, 1901.

Efficiency of the Pelton and De Remer Impact Wheels.

Sir: In your issue of Dec. 12, is a description of a Tangential Impact Water Wheel. It would appear that the intention of the writer was to give a comparison between the De Remer wheel and the Pelton.

The efficiency curves are supposed to be [illegible] each 12 ins. in diameter. There is evid[ently] something wrong, for the wheels are either not of the [same] diameter or else they were not arranged in the same [manner], as the one made 1660 r. p. m. when running [under] whereas the other made 1488 r. p. m. It is stated in [the] article that the water is brought to rest relatively to [the] wheel. This cannot be the case, because assuming it [to be] true, the water, when discharged from the wheel, [must] have an absolute velocity equal to that of the [wheel] and therefore a great deal of the energy [of the] would be lost, due to this high velocity [of] discharge. These efficiency curves are said to be [taken] made by Prof. Carpenter. Here again [is] something wrong, because Prof. Carpenter [has] he has gotten as high as 88% efficiency [for] wheel, whereas the highest efficiency shown [is] 76% in one of the curves and about 72% in [the] curves.

On the whole I think the article is unjust [and] to the Pelton wheel. I cannot see how it [is] get as high an efficiency from the De Remer [wheel] be gotten from a wheel with buckets having [only] splitter, because there, the surface exposed [to] a minimum and the bucket friction is [less] there are a number of splitters, as in the [case] De Remer bucket.

Yours very truly,

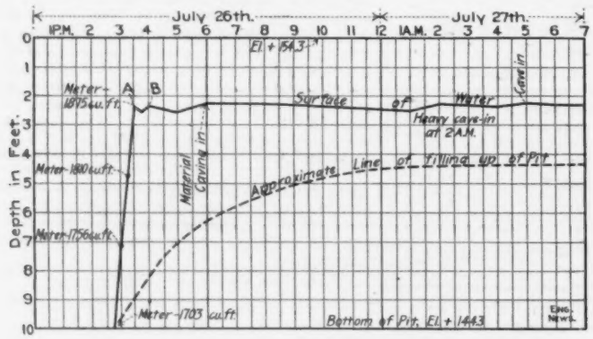
Geo. M. Peck.

No. 113 West 48th St., New York, Dec. 17, 1901.

BOOK REVIEWS.

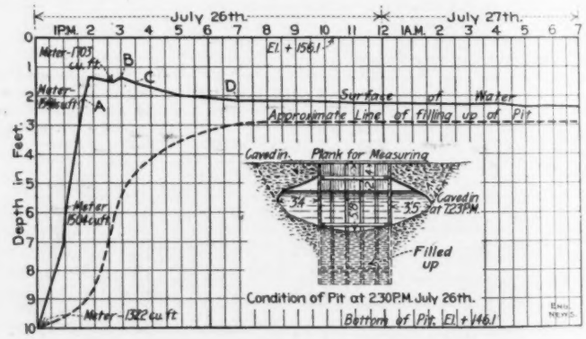
MATHEMATICAL DRAWING AND MEASURING INSTRUMENTS; Their Construction, Uses, Qualities, Selection, Preservation and Suggestions for Improvements, with Hints Upon Drawing, Coloring, Calculating, Sun-Printing, Lettering, etc. By William Ford Stanley. 7th Edition. London: E. & F. N. Spon; New York: Spon & Chamberlain. Cloth; 5 × 7½ ins.; pp. 370; illustrated. $2.00.

This is a most excellent work for the purpose intended, is a standard work in England, and should be exceedingly useful to every American engineer and draftsman. The author deals with his subject as one thoroughly familiar with the manufacture and use of every variety of drawing and measuring instrument, their good qualities and their treatment. The description of drawing-pens, dividers, compasses, instruments for making large circles, ellipses, parabolas, etc., is very complete and includes many instruments practically unknown in the majority of drafting rooms. Among the latter are pens for producing geometrical figures, instruments for making opposite-handed equal forms, triangular compasses for copying, or reducing or enlarging drawings. The pantagraph proper is given a full chapter, setting forth its use and varieties. In another most interesting chapter the author treats of instruments intended to facilitate sketching from nature, giving many valuable hints upon this too-much neglected subject. After this follow sections upon drawing-boards, sketching-cases, the plane-table and its use, tracing-tables, straight-edges and tee-squares. For architectural draftsmen a separate chapter is devoted to ruling-edges for producing radial or vanishing lines; another chapter relates to edges for making curved lines. All manner of drawing, mathematical, computing and calculating scales are described, again exhibiting a number seldom met with. The closing chapters refer to drawing paper and the best methods of handling it; sectional paper and the little conveniences about the drawing-table; to pencils, brushes, colors and coloring. The only objectionable chap-



A—At 3.31 p. m. material around sides of pit commenced to cave in. At 4.01 another bad cave-in. B—Dampness showed in some places on core-wall to 8 and 10 ins. above ground, water soaking through to wall and following it down the slope.

FIG. 4. OBSERVATIONS AT PIT NO. 5.
(10 ft. west of core-wall; 6 × 3 ft., 10 ft. deep.)



Dotted lines in sketch of pit show latter as excavated 10 ins. deep and protected with planking and shoring. Full lines show condition after sides and ends had caved in, 3.20 p. m. July 26.

From top of core-wall to surface ground, 9.6 ft.; where water broke through, 20 feet.

A.—At 1.40 p. m. water broke through north end of pit and flowed to pits Nos. 1 and 2.

B.—Sides of pit caving in and filling up, causing water to rise.

C.—At 3.30 p. m. a bar cave-in occurred and water commenced to leave pit rapidly.

D.—Continued caving of sides and ends of pit. Plank from which measurements were taken caved in at 7.04 p. m. North end of pit fell in at 7.23 p. m.

FIG. 5. OBSERVATIONS AT PIT NO. 6.
(10 ft. east of core-wall; 6 × 3 ft., × 10 ft. deep.)

ter in the book—to ourselves—is the one upon lettering drawings, where stencil-work is discussed in some detail and recommended as effecting an immense saving of time. Free-hand lettering, of the proper kind, takes little if any more time and is far more workmanlike and artistic in effect than any type of stencil work. The book is profusely and very well illustrated throughout.

CRAM'S STANDARD AMERICAN RAILWAY SYSTEM ATLAS OF THE WORLD.—Accompanied with a complete and simple index of the United States showing the exact location of all railroads, towns, villages and post offices; giving population, number of banks, telegraph, express and money-order offices, and express companies doing business over each road. Maps of the United States are the largest scale and clearest print of any maps published. Published by George F. Cram, 61-65 Plymouth Place, Chicago, Ill., and 130 Fulton St., New York city. Buckram; 14 × 20¼ ins.; pp. 65; Full World Edition, buckram, $12.50; half morocco, $15.00; full Russia, $20.00; business edition of United States and general maps of the world, buckram, $7.50; half morocco, $10.00; full Russia, $14.00.

In these maps—which are on an unusually large scale—each separate railway system is shown by distinctive colors and marking; and this distinction is the same in form for each state into which the system extends. At the top of each map is a page reference to each abutting state, and at the side of each map throughout the atlas is a full index of all the maps, so that no time is lost in hunting over a common, separate index. The place-index in each case indicates, by different type and marks, the county seat, post office, money-order office, telegraph station, prepaid freight station, rural free delivery, name of express company, and population. The names of the railways in each state, including electric railways, are given, together with the branch lines, steamship and steamboat connections, etc. Where the states are large, a full map of the state is shown, and this is followed by other maps showing sections of the state on a large scale. A banker's directory gives the name of every bank or banker in the United States, or a specially recommended bank for collection when the town contains more than one. To meet a demand for legal service in any town containing a bank, another directory gives a special list of attorneys in every banking town in the country. The official maps of cities are bunched together, so as to be easily accessible, and these are made on a large scale. The indexing in this atlas is especially systematic and satisfactory.

THE CHEMICAL AND PHYSICAL EXAMINATION OF PORTLAND CEMENT.—By Frederick K. Meade, Instructor in Chemistry, Lafayette College. The Chemical Publishing Co., Easton, Pa. Cloth; 4½ × 5¾ ins.; pp. 183; illustrated. $1.

This little book will, we believe, be to many persons a welcome addition to the technical literature on hydraulic cements. As the author well says, experienced chemists will perhaps find little that is new in the book, but to the young man fresh from a technical school, whose technical training may be excellent, but whose laboratory experience upon work of this kind is usually limited to a few analyses, it will prove a handy manual of the details of cement analysis. The book opens with an introductory chapter on the nature and composition of Portland cement and current theories of its hardening, which tells the analyst briefly the character and names of the ingredients whose relative quantities it is his problem to determine. At this point a paragraph of the author's will repay quotation for its concise and non-technical statement of the composition of Portland cement. Incidentally it will be noted that the author is a disciple of "fonetic" spelling:

> From this it will be seen that the essential ingredients of Portland cement are lime, silica and alumina. A little of the alumina is always replaced by ferric oxid, and some of the lime by magnesia. Small percentages of alkalies, potash and soda, present in the clay as silicates, are also in cement, while the most thorough burning fails to drive off all the carbon dioxid from the limestone or marl in the raw mixture, leaving a trace in the finished product. This trace is increased by the absorption of the constituent from the atmosphere. Coal contains sulfur; this when burned becomes sulfur dioxid, a gas which is absorbed by the uncombined lime of the cement mixture, or left in the ash when it unites with lime to form calcium sulfate. Some sulfur also enters the cement from the clay or marl. These are the chemical constituents for which cements are mainly analyzed. Usually it is sufficient to know the silica, lime, alumina and ferric oxid together, and the magnesia; less often the alumina and ferric oxid separately, the sulfuric acid and the carbon dioxid; while more rarely yet the alkalies, combined water and the sulfur present as sulfate and sulfid respectively.

With this statement, the author proceeds with a description of the methods of analysis, first, for cement; second, for raw cement mixtures; third, for limestone, and, fourth, for clay. The apparatus and reagents used and the methods of their manipulation are given step by step in detail for each of the various ingredients. The succeeding chapter outlines briefly the usual physical tests and the apparatus used and methods employed in conducting them. This chapter is a concise summary of current practice, but it naturally contains little that is not contained in any one of half a dozen well-known text-books. For the chemist who is not conversant with methods of making physical tests of cement, it doubtless serves a good purpose, and this is acknowledged by the author to be the chief field of its usefulness. The closing chapter of the book discusses all too briefly the various proposed methods of detecting the adulteration of Portland cement.

CONCERNING THE "OLD OAKEN BUCKET."

It is not often that Engineering News emulates the example of Silas Wegg and "drops into poetry." We find in the correspondence columns of the "New York Times," however, a parody which may serve to amuse our readers as it has us. It was written by Dr. Jas. C. Bayles a number of years ago, when he occupied the position of President of the Board of Health of New York city, and was read at a meeting of the New York Academy of Medicine. The sanitary science conveyed in the verses may seem elementary indeed to our readers, yet it needs but the slightest knowledge of conditions about the average farmhouse and country village to realize that millions of people are living amid just such unhealthful surroundings in entire ignorance that they have anything to do with causing disease and death. The parody is as follows:

With what anguish of mind I remember my childhood,
Recalled in the light of a knowledge since gained,
The malarious farm, the wet fungus-grown wildwood,
The chills then contracted that since have remained;
The scum-covered duck-pond, the pig-sty close by it,
The ditch where the sour-smelling house drainage fell,
The damp, shaded dwelling, the foul barnyard nigh it—
But worse than all else was that terrible well,
And the old oaken bucket, the mold-crusted bucket,
The moss-covered bucket that hung in the well.

Just think of it! Moss on the vessel that lifted
The water I drank in the days called to mind;
Ere I knew what professors and scientists gifted
In the waters of wells by analysis find;
The rotting wood fiber, the oxide of iron,
The algae, the frog of unusual size,
The water, impure as the verses of Byron,
Are things I remember with tears in my eyes.

And to tell the sad truth—though I shudder to think it—
I considered that water uncommonly dear,
And often at noon, when I went there to drink it,
I enjoyed it as much as I now enjoy beer.
How ardent I seized it with hands that were grimy,
And quick to the mud-covered bottom it fell,
Then reeking with nitrates and nitrites, and slimy
With matter organic it rose from the well.

Oh, had I but realized in time to avoid them—
The dangers that lurked in that pestilent draught—
I'd have tested for organic germs and destroyed them
With potassic permanganate ere I had quaffed.
Or perchance I'd have boiled it, and afterward strained it
Through filters of charcoal and gravel combined;
Or, after distilling, condensed, and regained it
In potable form, with its filth left behind.

How little I knew of the enteric fever
Which lurked in the water I ventured to drink,
But since I've become a devoted believer
In the teachings of science, I shudder to think.
And now, far removed from the scenes I'm describing,
The story of warning to others I tell,
As memory reverts to my youthful imbibing
And I gag at the thought of that horrible well,
And the old oaken bucket, the fungus-grown bucket—
In fact, the slop bucket—that hung in the well.

EXPERIENCE WITH TAR-MACADAM PAVING IN GLASGOW.

Shortly after the publication of articles on proposed asphalt-macadam pavements in our issues of June 6 and July 4, we received a communication from a correspondent who informed us that a pavement of this type had recently been laid in Glasgow. We therefore requested an American engineer resident in Glasgow to examine the pavement and inform us as to its condition. It should be said, however, that the pavement appears to be a tar-macadam, and not the type of pavement described in the contribution referred to above.

A recent letter from the engineer referred to informs us that he examined the pavement several times during the past season, and has found it in bad condition, containing many hollows and cracks, and it was soft in hot weather. A letter was sent to the Glasgow Street Commissioner asking for his opinion of the pavement, and a letter was received in reply from which we quote as follows:

> Sir: I presume the pavement you refer to is the tar-macadam laid in Buchanan St. last year between Argyle St. and Exchange Place. It has not been a success and my committee have been very much dissatisfied indeed with it. As a matter of fact, Messrs. Walker have been repeatedly during the summer lifting and relaying large patches of it and are doing the same thing at night just now. It is only fair, however, to Messrs. Walker to state that it was laid in a very wet season and was even laid against Messrs. Walkers' wish, but on account of the condition of the street at the time it was impossible to allow the matter to lie over. Generally speaking, our experience of tar-macadam as a paving material in Glasgow is that it is not sufficient where there is considerable traffic. In quiet residential streets, as a substitute for ordinary macadam, it is, I believe, an excellent material, but as a substitute for stone setts or wood block paving it is not a good one. It is comparatively noiseless, non-slippery, unless in frosty weather, when all smooth pavements are slippery, and it is easily cleaned. I think also that if laid during the summer time in dry weather the ordinary weather conditions will not affect it.

SINKING FOUNDATION WELLS FOR THE KOYAKHAI BRIDGE, BENGAL-NAGPUR RAILWAY.*

By Graves William Eves,† B. A. I., Assoc. M. Inst. C. E.

The foundations of the Koyakhai Bridge consist of single wells, 26 ft. 6 ins. in diameter, sunk 100 ft. apart, center to center. The well curb for a breadth of 3 ft. splays inwards at an angle of about 45°. The steining is increased inwards by 6-in. offsets every 1-ft. course till the wall attains a thickness of 6 ft. 6 ins., leaving a dredging chamber in the center 13 ft. 6 ins. in diameter. As much difficulty was experienced in sinking through clay, the offsets were reduced to 3 ins. every 1-ft. rise and were chamfered to a smooth inward batter of 1 in 4.

The weight of the stone employed is 143 lbs. per cu. ft., which gives a weight of about 25 tons per ft. run of well, allowing for the steining at the bottom not being quite as thick as the upper lengths. The masonry was commenced 26 ft. 6 ins. in diameter, leaving no offset on the outside above the well curb. In some of the wells a 1-in. offset was left, but no difference could be found in sinking, as the clay must have closed in on this offset, on account of the weight of the sand and clay above.

The sand of the river was very fine but clean, and was too fine for use in mortar. The clay was dark blue and very hard; brittle when quite dry, but like leather when under water. When excavating in sand the dredger excavated a hole about 5 ft. below the cutting edge, the sand sloping up to the curb. When the dredger first touched the clay the cutting edge was about 3 ft. above it, and a 2-oz. charge of dynamite brought the curb to within 1 ft. of the clay, but no further. The dredgers (which were Bruce three-bladed machines, weighing about 18 cwt. each) could make no impression in the clay, and in order to break it up it was found necessary to employ diggers, made by riveting together five double-headed rails, each 20 ft. long and weighing 64 lbs. per yd. The two outer rails were splayed outwards like a trident and were sharpened; the center rail was also sharpened and the other two were cut off at about 2 ft. 6 ins. from the end. This was worked up and down by the steam hoist, and, being top heavy, when it was driven in it tended to fall over, thus digging up the clay. In this manner a hole 13 ft. 6 ins. in diameter and 1 ft. in depth could be dug and dredged in 24 hours. When a hole 15 ft. in depth below the level of the curb had been dug the weight of the well forced the cutting edge about 4 ft. or 5 ft. into the clay, but it was found impossible to undercut the steining, the curb having to wedge inwards a thickness of 6 ft. 6 ins. of clay. Digging the hole deeper produced no better result, a depth of 40 ft. being attained in some wells without effect. It was therefore necessary to undercut the steining by other means. To do this four methods were available, namely, (1) baling out water, (2) blasting inside the well, (3) blasting in bore holes sunk just outside, and (4) artificially adding weight if no more masonry could be built.

Baling water out of a well helps to sink it in two ways: first, by lowering the water level on the inside, flotation is diminished; and, second, by the difference of pressure inside and outside, the clay is forced inwards, the flow of water under the curb breaking the clay away in its passage under the cutting edge. To find the exact amount of weight added is a very difficult problem, as the water remains at the original level on the outside of the well. The great disadvantage of lowering the water level inside a well was that it made it blow. If a sufficiently large amount of clay fell in with the blow, the well generally went down and stopped the blow for a time, but it was always liable to start blowing afterwards in the same place, and then if the blow did not stop the sand ran into the well as fast as it was dredged out. Bags full of sand and clay were put down outside the well, but they were sucked into the center and brought up by the dredger almost as fast as they were put into the blow hole. In only one case was a well ever completely dried, although the clay was so hard it seemed to be traversed by cracks

*From selected papers of the Institution of Civil Engineers.

†18 Garden Reach Road, Kidderpore, Calcutta.

large enough to prevent the water level being lowered by more than 10 ft. or 15 ft. on an average.

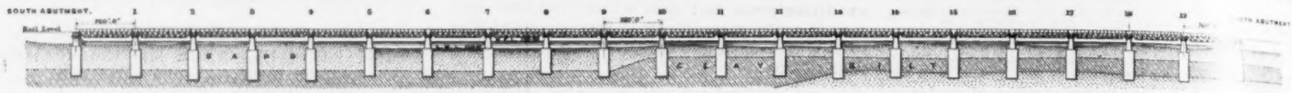
In the correspondence on the papers on "Railway Bridges," by Messrs. Burge, Walton and Cruttwell, read before the Institution, Mr. Parkinson* wrote saying that in brick wells the suction of moisture from the surrounding soil due to lowering the water level inside the well increased the friction to such an extent that the clay next the well clung to the well so hard as to break away from the surrounding clay and be carried down with the well. This probably accounted for the fact that wells did not often go down while water was being baled out. Water baling probably acted most beneficially by the rush of water under the curb forcing the clay under the steining inwards. No evil effects due to sudden rises resulted from keeping the water at a lower level inside the well, as the masonry was very well bonded together.

best to be on the safe side. The stone pitching was largely accountable for the well not going down, as some of the stones must have become wedged between the clay and the steining.

When deciding on the depth to which a well should be sunk, skin friction is seldom taken into account. In Indian rivers the depth of scour in a big flood is an unknown quantity. The movement which takes place in the sand makes it necessary to neglect the skin friction for the first 40 to 50 ft. at least. The well must be sunk to a depth sufficient to give it stability against overturning, and this depth will generally be found to be greater than that necessary to prevent vertical downward movement. The most reliable data relating to skin friction were gathered from wells Nos. 13, 15, 16 and 17. These wells were sunk 5 ft. to 8 ft. into the clay without much difficulty by small charges of dynamite. A hole was then dug to a

obtains when the maximum wind pressur[illegible] lbs. per sq. ft. occurs at the same time as a max[illegible] flood. As the wells are filled with sand from the [illegible] to within 15 ft. of the top, the weight of this sand [illegible] not taken into account as adding to the stability, as [illegible] does not form part of the well, but rests on the cla[illegible] the bottom quite independently. To give increase[illegible] stability the author is of opinion that there should be [illegible] of concrete at the bottom of the well to keep [illegible] inside the well and also to give increased bear[illegible] at the level of the cutting edge.

The method of sinking the Koyakhai wel[illegible] increased the vertical stability of the wells very much. [illegible] of dynamite blew great holes in the und[illegible] & subsoil outside the wells, which in many cases wo[illegible] probably not filled up by the sand finally put inside the [illegible] This reduced skin friction, and when the superstru[illegible] was put



THE KOYAKHAI BRIDGE OVER THE ORISSA RIVER; BENGAL-NAGPUR RY., INDIA.

When the foregoing method failed to send the well down blasting by dynamite was tried. At first only very small charges of 4 oz. or 5 oz. were exploded at great distances below the well curb, and as these became insufficient to send the well down larger charges were used, until finally as much as 5 lbs. was exploded at one time. The dynamite was made up in cartridges, each containing about 2¼ ozs., and the author made it a rule never to blast nearer the well curb than a distance of 1 ft. vertically for every cartridge in the bundle. In general eight charges of 4½ ozs. each (two cartridges) were arranged in a circle 2 ft. lower than the cutting edge; these were let down by strings just inside the steining, with a fuze and detonator in each. The charges exploded simultaneously, as the shock of one explosion set off the others. Six sets of three cartridges each, 3 ft. below the cutting edge, were then used, and finally four sets of six cartridges and four sets of eight cartridges, at a depth of 8 ft. below the cutting edge, were employed. When this process had been gone through, all the clay loosened by the blasting was dredged out clean and the operation was gone through again. The process had to be repeated till the well went down. If the well did not go down after a week of this treatment, it was generally left alone for a time while the steam hoist was working on another well, and in three or four cases the well went down while no one was working on it. The greatest drop was one of 17 ft. 6 ins., which took place on No. 2 pier at 5.30 in the morning. This went down in about 3 seconds, and the water rose about 8 ft. or 10 ft. above the level of the top of the well, washing away the trolley and water baling box, which fell clear, and the dredger, which fell into the well. This happened 12 hours after water baling was stopped and three days after the last charge of dynamite was blasted in it.

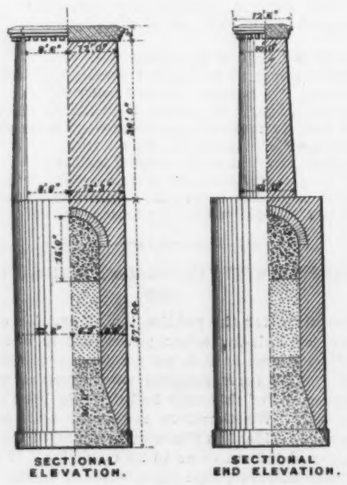
The fact that all the charges went off simultaneously led the author to try some blasts with a detonator in only one of the bundles of cartridges. Eight bundles of three cartridges each were lowered 3 ft. below the cutting edge, just inside the steining, without fuze or detonator, and one bundle of ten cartridges was placed in the center with a detonator and fuse. The center charge, on exploding, exploded all the others on every occasion that this method was tried. Even this enormous charge never sent the well down at the time, all sudden drops occurring four hours or five hours afterwards, when the loose clay was being dredged out.

Another method was tried on one well, namely, putting down 6-in. bore holes outside the well, about 3 ins. clear of the masonry, and blasting dynamite in these. Two holes were put down at opposite sides. The boring tool worked down to 15 ft. below the cutting edge of the curb, the boring tube stopping short about 10 ft. below the curb. A blast of two cartridges in each hole produced nb effect, and as even six cartridges in each hole produced no better result the method was abandoned. Dredging was stopped and the well went down 5 ft. 6 ins. when the masonry was being built. All the wells from abutment No. 1 to pier No. 10 required extra weight added to them after the last length of masonry was built. For this purpose 400 tons of rails were put on one well. On the others dry masonry was built to give extra weight, generally about 500 tons.

At the end of the hot weather of May, 1898, wells Nos. 7, 8 and 9 had just reached clay about 60 ft. below the bed of the river. By charges of dynamite they were sunk about 4 ft. into the clay, and then 15,000 cu. ft. of pitching was put round them to protect them from floods. When work was continued after the rains this stone proved a great hindrance to the work. Only about half could be reclaimed, the rest having sunk with the scour to too great a depth under water to be recovered. These stones gradually sank when the well blew, and eventually many were brought up by the dredger from inside the well. No flood sufficiently large to necessitate the pitching being put round the well was experienced, but it was thought

depth below the curb equal to twice the depth to which the curb was already sunk in the clay. The dredging was then stopped and the addition of masonry commenced, notes being kept of the amount of masonry built when the well started to sink due to the extra weight. From these four wells four equations connecting three unknown quantities were formed by equating the total weight of the well when it started to sink to the skin friction of the sand and clay, together with the vertical reaction of the 6 ft. 6-in. ring of clay under the steining. For every value given to one of these unknown quantities corresponding values can be calculated for the others. The value of 2.5 cwt. per sq. ft. for sand was therefore assumed, and the corresponding values for the other unknown quantities from the most reliable data were 12 cwt. per sq. ft. for the friction of the clay and 1 ton 15 cwt. per sq. ft. as the resistance of the clay to being squeezed inwards by the wedge-shaped curb. The data from which these values were deduced were obtained from No. 10 well. This well was sunk about 20 ft. into the clay without any undercutting of the curb, but it stuck at that depth for a very long time, during which a great deal of dynamite was blasted. A diver was sent down to examine, and he reported that the ironwork of the well curb was bare nearly all the way round, so that the vertical reaction could only have been small. From these data, and assuming the foregoing values for sand and clay, the value of the vertical reaction was found to be only 6 cwt. per sq. ft. of cross-section of the steining.

Whether these figures for skin friction will be useful in determining the depth to which wells ought to be sunk is



Sections of Piers for Koyakhai Bridge.

doubtful. The only way in which wells have been known to fail is by overturning, due to the bed of the river being scoured out. The axis about which the well tends to rotate is parallel with the center line of the bridge, and for foundations other than rock should not be at too great a distance from it. The weight of the well multiplied by this distance gives the moment of stability of the well. The greater the depth of the well the greater will be the weight, and consequently the greater the moment of stability; but by increasing the depth the moment of wind and current pressure is also increased; the former, however, is increased in greater proportion than the latter. Without taking skin friction into consideration, and calculating the stability of the well as a retaining wall, the line of stress passes through a point 4 ft. 5 ins. from the center line, which is just within the middle third. This

on the wells the settlement was very grea[illegible] The south abutment was surrounded with dry stone, [illegible] in front, to a height of about 50 ft.; this caused a s[illegible] of over 4 ins., the bank next the abutment sinking [illegible] ins. more than it did elsewhere, though consisting of sand. The undercutting could not be regulated in any way.

The hole under the well being filled with [illegible], the resistance to tilting of the well would be very small. On the slightest overturning movement the curb would cut into the sand of the down-stream side and the sand so displaced would be squeezed into the space left by the upward motion of the curb on the up-stream side. This could have been remedied in the following manner: As there was plenty of rubble stone to spare, this might have been thrown into the hole under the cutting edge, throwing in at the same time enough sand to fill the spaces between the rubble. From the cutting edge to the level at which the steining attains the thickness of 6 ft. 6 ins. the proportion of sand should be increased in order to pack better underneath the inward batter of the steining. On the top of this a concrete plug should be laid, to make the weight of the sand filled inside the well available for increasing the stability against overturning. The author is of opinion that it is inadvisable to rely on divers packing or ramming concrete or dry stone underneath the inward batter of the steining in 80 ft. of muddy water.

*Minutes of Proceedings Inst. C. E., vol. ci., p. 70.

REVISION OF STREET RAILWAY FRANCHISES AT BRUSSELS, BELGIUM.

The International Tramway Union has recently published some particulars of the steps taken at Brussels, Belgium, to put the various street railway franchises, under which the lines in the city were operated, upon a uniform basis. The information was furnished by M. Leon Janssen, Director-General of the Brussels Tramways Co.

The law which governs the franchises of the Brussels tramways was enacted in 1875, but most of the lines existed before this law was passed, and the various lines composing the system now owned by the Brussels Tramways Co. were built under various franchises, granted by the communes or local authorities, and having no uniformity in their conditions or requirements. As the law of 1875 did not relate to existing franchises, the legal status of some of these old franchises became a matter of doubt. The system is composed of 25 miles of lines whose franchises expire in 1942, and 10 miles of lines whose franchises expire in 1909, 1910 and 1911, together with the recently acquired 18-mile narrow gage railway to Ixelles-Boendael, the franchise for which expires in 1950.

In order to effect a unification of the franchises, negotiations with the government were begun, and have resulted in the adoption of an agreement between the State and the tramway company, in 1899.

The principal conditions of the agreement were as follows:

1. The date of expiration of all the franchises for all the lines was fixed at Dec. 31, 1945.

2. The company is to pay the State $500,000 for works on the public highways.

3. The company is to pay higher rentals than those paid in the past to the city and the communes. The city receives a variable sum, based upon the amounts distributed as dividends to the stockholders.

4. The fares are to be reduced to a maximum of 3 cts. for any distance, with a minimum of 2 cts. (in the second-class compartment or car). An

extra rate is charged for first-class passengers on the lines in the upper parts of the city (that is, in the wealthy residence districts). On week days there is a uniform rate of 2 cts. up to 8 a. m., and from 7 to 8 p. m. (19 to 20 o'clock, Belgian reckoning) for the benefit of workmen. An eventual reduction to a 2-ct. rate at all hours is provided for, based upon the growth of net receipts.

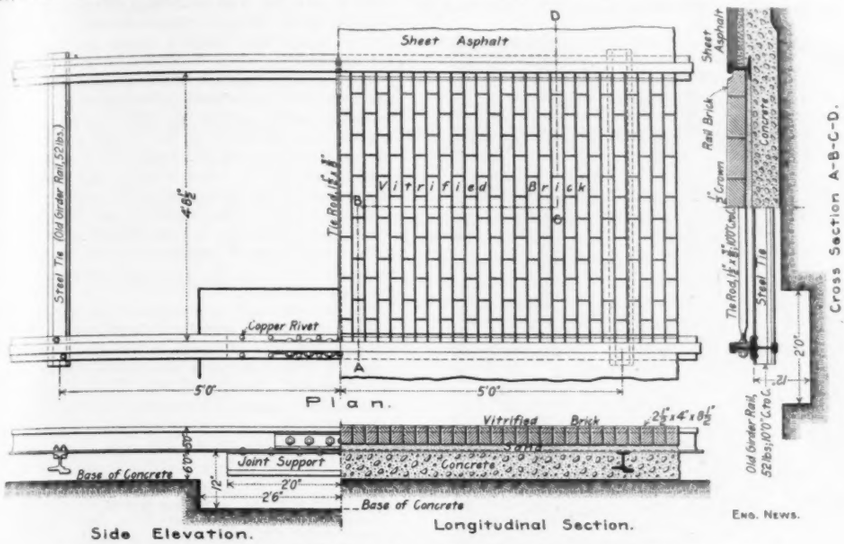


FIG. 1. STREET RAILWAY TRACK CONSTRUCTION OF THE SCRANTON RY. CO.; SCRANTON, PA.
Frank Silliman, Jr., General Manager.

5. A transfer system is to be established at 1 ct. for a single section of the line, or 2 cts. for the entire line.

6. A clause is inserted providing for the purchase of the system by the municipal authorities.

7. The works, tracks, fixed material and rolling stock, but not the stations or buildings, are to be delivered free to the authorities on the expiration of the franchise.

8. Stipulations in the interest of the employees include minimum rates of wages and maximum hours of work.

9. The conversion of all the lines to electric traction within five years is required, the State having the power to pass upon the type of system to be adopted.

Under the last clause it was decided to install the overhead trolley wire system where it had not already been installed (16 miles), and the underground electric conduit system for 3 miles.

STREET RAILWAY TRACK CONSTRUCTION AT SCRANTON, PA.

With the object of securing a street railway track which will be economical in the maintenance of both the track and the adjacent pavement, a very substantial system of construction has been adopted by the Scranton Ry. Co. This track comprises a concrete base, T-rails, steel ties and reinforced joints, with brick and asphalt paving. For particulars, drawings and photographs of this construction we are indebted to Mr. Frank Silliman, General Manager of the company.

Fig. 1 is a general plan and section of the track, showing the details of construction. The rails are of T-section, the company being of opinion that it will be possible to get much better service and less wear with rails of this section than with side-bearings rails having a "tram" for wagon wheels. In that community there is very little wear of the trams of rails due to wagon traffic, the entire wear of the rails being confined to the heads. For this reason the flanges of the car wheels begin to ride on the tram of the rail when the head is worn. This makes a very bad riding track, besides having a tendency to roll the rails out of shape and place, and to break them at the ends, as the wear at the joints is, of course, much faster than at other parts. With the deep-headed T-rail there is no such difficulty, the groove in the paving allowing full clearance for the flanges of the wheels.

Until 1900 most of the rails weighed 57 lbs. per yd., and were 5 ins. high and 5 ins. wide over the base, being of the Pennsylvania Steel Co.'s section No. 253 (Fig. 2). Since early in 1900, however, a 65-lb. rail, 6 ins. high and 5½ ins. wide on the base, has been substituted. The increased height allows a more substantial sand cushion for brick pavement, and the wider base gives a better bearing on the concrete. Mr. Silliman believes that the rail would be further improved if the base were still wider, but it has not been possible to get the mills to roll any other sections than their standards. The rails are furnished in 60-ft. lengths, thus reducing the number of joints by 50%, as compared with the ordinary 30-ft. rails. They are laid with broken joints, and the joints are spliced by 27-in. splice bars of channel section with eight bolts. At each joint and at intervals of 10 ft. is a flat tie-bar, ⅝ × 1½ ins., with threaded ends which pass through the rail web at one end and through the rail and splice bars at the other, being secured by ¾-in. nuts on both sides of each rail. Under each joint is an inverted piece of the same rail as that used for the track, 4 ft. long, secured by ¾-in. rivets through the flanges, nine rivets on each side. Four of the rivets are of copper, ¾ × 1½ ins., acting as rail bonds to facilitate the passage of the electric current past the joints. In addition to this, a bond of the protected type, of 425,000 circular mils area, is placed under the splice bars. All of these bonds are upset by a powerful screw compressor. The joint is shown in Fig. 1, and Fig. 3 is a view of the completed joint.

The joint supports are embedded in the concrete base, which adds to the stiffness and prevents the joints from rising or going down. At intervals of 10 ft. the rails are connected by steel cross-ties, formed of pieces of old 52-lb. side-bearing girder rails, 4 ins. high and 3 ins. wide over the base. These are inverted and are secured to the track rails by two rivets, ¾ × 2 ins., at each end. These also are embedded in the concrete. The steel ties are placed midway between the tie-bars. The track rails rest directly upon a concrete base, extending the full width of the street. This is normally 6 ins. deep, but is increased to a depth of 12 ins. for a space 2 × 5 ft. at each joint and 1 × 6 ft. at each steel tie.

Special care is taken in the construction of the track. After the grading has been done, the subgrade is rolled with a 10-ton steam roller to give a firm surface 6 ins. below the level of the rail base, the depth being increased to 12 ins. under the joints and ties, as already noted. Wooden blocks are placed temporarily upon the subgrade, and on these the rails were laid. After the joints have been bolted and riveted up and the steel ties bolted on, the track is lined and surfaced. The concrete is then deposited upon the subgrade and well tamped under the rails, so as to give them an even and uniform bearing. The concrete is mixed by machine and composed of 1 part Portland cement, 3 parts sand and 5 parts broken stone. It is allowed to set for from five to seven days.

Special appliances are provided for the work. The riveting is done by a portable pneumatic riveter of the jaw or "squeeze" type, made by Chester B. Albree, of Allegheny, Pa. (Eng. News, 1897, II, 246; 1898, I, 222). This is suspended from a derrick mounted on a four-wheel flat-car, which runs on the rails of the track to be riveted. This car also carries an electrically driven air compressor made by the U. Baird Machinery Co., of Pittsburg, Pa., and driven by a 500-volt motor of the Lundell type. The air is compressed at 80 lbs. pressure in a receiver on the car. This plant is shown in Fig. 4, which also shows one of the steel ties in place.

A considerable amount of the riveting has also been done by hand work, using a set and sledge.

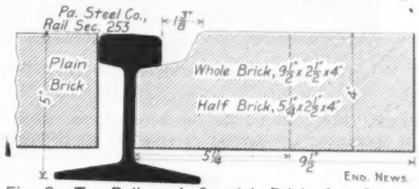


Fig. 2. Tee-Rail and Special Brick for Groove; Scranton Ry. Co.

This is very effective in certain situations, where it is difficult to get the dies of the pneumatic riveter properly located.

The concrete mixing machine is of the Drake pattern, made by the Drake Standard Machine Works, of Chicago (Eng. News, 1901, I, 149), having blades on a horizontal shaft revolving in a mixing trough, the blades not only mixing the concrete, but driving it towards the end of the trough. The materials are dumped into the trough from measuring boxes, and the concrete is delivered at the end of the trough, falling directly into the space between the rails. This machine has a capacity of 200 yds. per day. It is driven by gearing by a 30-HP. Westinghouse street railway motor, operated by a 500-volt circuit. The machine is mounted on a low platform car or truck running on the track. On new lines the truck is run on the track as soon as it has been blocked up, riveted, bolted, surfaced and

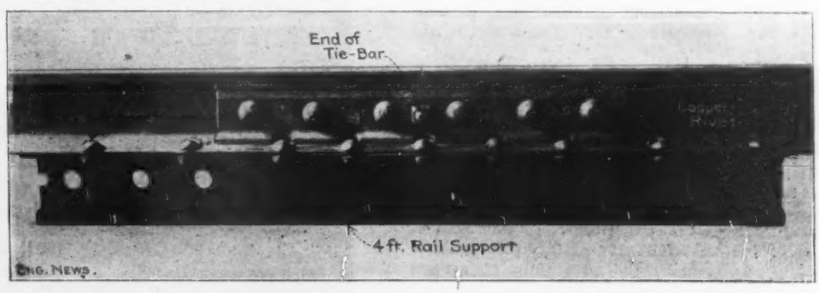


FIG. 3. VIEW OF REINFORCED JOINT OF SCRANTON RY. CO.'S TRACK.

lined, all ready for the concrete. The truck is moved slowly forward as the work of concreting progresses. The machine is swiveled upon the track so that it may be turned end for end or sideways. It can thus be used to concrete all of one track, and on double track it can deposit the concrete more than half way over to the second track. Fig. 5 shows the concrete mixing machine in operation. Power for driving the air compressor and concrete mixer and for propelling the cars upon which they are mounted is taken from the 500-volt circuit of the overhead trolley wire of the street railway.

FIG. 4. RIVETING PLANT FOR RAIL JOINTS; SCRANTON RY. CO.

(Showing reinforcing rail under the joint, and also one of the steel cross ties at the right.)

Some difficulty was anticipated and experienced at first in keeping the track in line after it was riveted up. To avoid excessive contraction and expansion during the time that the track was exposed, it was found advisable to follow up the riveter with the concreting force as closely as possible, and to immediately cover the rails with sand when the concreting was finished. This protected the rails from extreme changes of temperature and enabled the work to be prosecuted without much trouble from the track springing out of line. Up to the present time about six miles of track have been laid on this system and it has given good satisfaction.

In regard to laying street railway rails directly upon the concrete, as in this case, it may be noted that objection has sometimes been made that such a practice makes a hard riding and uncomfortable track and causes excessive wear of rails, wheels and rolling stock. In the editorial on "Electric Railway Construction and Operation" in our issue of Aug. 29, it was shown that this objection is not sustained by actual experience. In this connection we quote the following extract from a letter sent to us by Mr. Silliman describing his system of construction:

> I would say that we do not find that this construction makes a hard-riding track in any degree whatever. The track is, of course, perfectly rigid, but the fact that the rails are practically buried in pavement up to the tops of the rails, seems to be enough to prevent any noise due to the rigidity of the track. So far from being hard riding, however, it is a very easy riding track on account of its almost perfect smoothness. There may be a little more noise in case there is any dirt on the top of the head of the rail, than in the case of a track laid on wooden ties, but this is hardly perceptible. As to the wear of rails, joints, wheels and rolling stock: Not having had more than three years' experience with this type of construction, we are not in a position to state anything definite as to this.

The street paving is of vitrified brick and asphalt. Brick is used in all cases between the rails, being laid on a 2-in. cushion bed of sand on the concrete base, with a crown of ¼-in. The bricks are 2½ × 4 × 8½ ins., and special bricks are laid next to the inside of each rail to form the groove, the top of the brick being ¼-in. below the head of the rail. These special bricks are 2½ × 4 ins. in section and 5¼ and 9½ ins. long alternately, so as to give broken joints for the paving. Where brick paving is used for the entire street, the ordinary paving bricks are placed against the outside of the rails. Where asphalt paving is used outside the rails, a concrete filling is laid upon the regular concrete base, upon which is a binder course, finished with the sheet asphalt surface, which is laid directly against the rail head. The brick paving between the rails is laid ½-in. high, above the finished surface, and is then rolled flush with the rails by a 5-ton roller mounted on a truck and running on the rails of the track, which is rather a novel method of using a street roller. This gives a smooth finished surface to the paving and brings it exactly level with the heads of the rails.

It is important that in laying the special bricks next to the rail and providing for the clearance for the wheel flanges, there should be plenty of groove space and such a shape to the special bricks that the wheel flanges may crowd the dirt (which will accumulate in the groove) away from the rail. The experience in Scranton showed that in some places, where the groove was made too narrow and the slope of the bricks was too near the vertical, the accumulated dirt in the groove was pressed by the wheel flanges until the ends of the special bricks were broken off, and the accumulation in the opening made by the broken brick, when frozen, raised the pavement between the rails. It is entirely practicable, however, to obviate this difficulty by the use of properly shaped grooved bricks.

The accompanying statement of the cost of track construction has been furnished us by Mr. Silliman. It was prepared by Mr. E. D. Reed, the engineer, and represents the actual cost in one of the streets of a track laid with 65-lb. T-rails on a 6-in. concrete base and paved with vitrified brick.

COST OF STREET RAILWAY TRACK CONSTRUCTION AT SCRANTON, PA.

Material:		
1 ft. track rails (43½ lbs.) at $42.10 per gross ton		$0.8147
Joint plates, $1.97 per 30-ft., per ft. track		.0066
Joint rail, $1.73 per 30-ft., per ft. track		.0576
Tie rods, 34 cts. per 10-ft., per ft. track		.0340
Iron rivets, 2 cts. per lb., per ft. track		.0071
Copper rivets, 18 cts. per lb., per ft. track		.0060
Total		$0.9854
Labor:		
Cost of tearing out old single track, hauling same away, hauling new material, drilling and punching all tie-rods and rivet holes, cutting and drilling steel ties, assembling work ready for concrete and bonding with copper rivets, complete, per ft. of track		0.4870
Paving:		
Cost of 1 ft. of track graded, rolled, concreted and paved with brick, at $1.97 per sq. yd.	$1.0933	
Extra concrete at joints and ties, at 72 cts. per sq. yd.	.0746	1.1679
Total		$2.6403
Add 1.5 cts. per ft. of track for fuel, tools, &c.		.0150
Total		$2.6553

Note:
Average haul of material, 2 miles.
Brick next to rail is of a special grooved shape.
Measurement for pavement is taken from outside to outside of head of rail.
These figures include the installing of one turnout.

Extra concrete is as follows:
2 ft. × 5 ft. × 6 ins. under joints.
1 ft. × 6 ft. × 6 ins. under ties.
The steel ties are made of old 4-ft. girder rails, and no value is placed on them in these figures.
The cost of grading and rolling is included in cost of pavement.

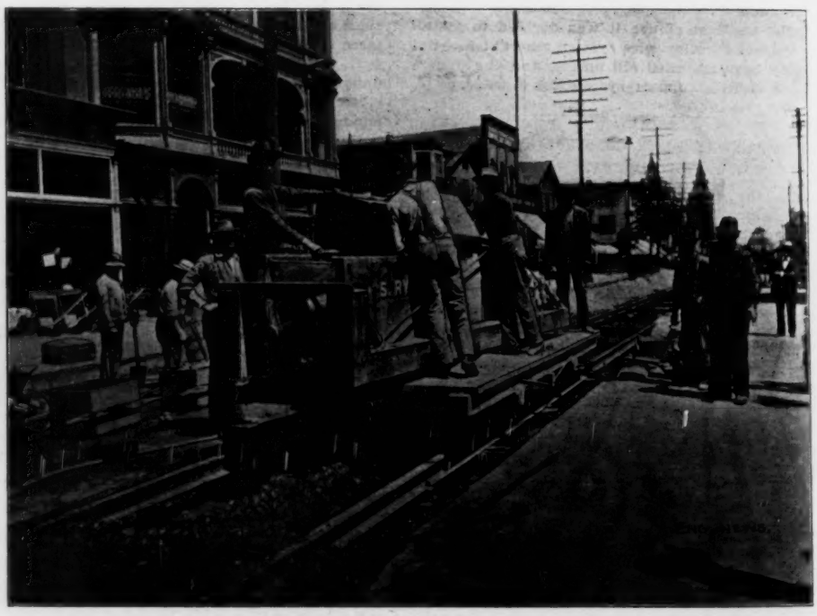


FIG. 5. CONCRETE-MIXING PLANT; DELIVERING CONCRETE BETWEEN THE RAILS.